

ECBC-TR-

**TEST RESULTS OF PHASE 2 LEVEL A SUITS TO
CHALLENGE BY CHEMICAL AND BIOLOGICAL
WARFARE AGENTS AND SIMULANTS:
SUMMARY REPORT**

Robert S. Lindsay

RESEARCH AND TECHNOLOGY DIRECTORATE

Alex G. Pappas

ENGINEERING DIRECTORATE

February 2001

Approved for public release, distribution is unlimited.

Disclaimer

The findings in this report are not to be construed as an official Department of the Army position unless so designated by other authorizing documents.

REPORT DOCUMENTATION PAGE			<i>Form Approved OMB No. 0704-0188</i>
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.			
1. AGENCY USE ONLY (Leave Blank)	2. REPORT DATE February 2001	3. REPORT TYPE AND DATES COVERED Final; 99 Jan – 99 Sep	
4. TITLE AND SUBTITLE Test Results of Phase 2 Level A Suits to Challenge by Chemical and Biological Warfare Agents and Simulants: Summary report		5. FUNDING NUMBERS None	
6. AUTHOR(S) Lindsay, Robert S. Pappas, Alex G.			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) DIR, ECBC, ATTN: AMSSB-RRT-CE, APG, MD 21010-5424		8. PERFORMING ORGANIZATION REPORT NUMBER ECBC-TR-	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) CDR, SBCCOM, ATTN: AMSSB-ODP, APG, MD 21010-5424		10. SPONSORING/MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES			
12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.		12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) Swatches from six commercially-available Level A protective suits were challenged with liquid droplets of Sarin (GB) and mustard (HD) using modifications of the static diffusion procedure described in TOP 8-2-501. The cumulative mass of each agent that permeated each swatch was determined over time, and the results for all swatches were used to determine a weighted-average cumulative mass for each suit. From these data, a breakthrough time was calculated for each suit for the purposes of comparison. In addition, intact suits were challenged with corn-oil aerosol to simulate biological and chemical aerosols. Protection factors were determined for each suit.			
14. SUBJECT TERMS HD Swatch testing Permeation testing GB Aerosol Testing Chemical protective suits			15. NUMBER OF PAGES
			16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT UNCLASSIFIED	18. SECURITY CLASSIFICATION OF THIS PAGE UNCLASSIFIED	19. SECURITY CLASSIFICATION OF ABSTRACT UNCLASSIFIED	20. LIMITATION OF ABSTRACT UL

EXECUTIVE SUMMARY

As part of the Domestic Preparedness Program, six Occupational Safety and Health Level A* suit designs were tested to assess their capability to protect in a chemical warfare (CW) agent or biological agent environment. Swatches of material from each suit design were tested for resistance to permeation for Sarin (GB) and mustard (HD). From this data, the authors calculated the estimated time it would take to permeate the suit with sufficient agent to cause physiological effects in a person wearing the suit. Each suit design was also tested for its protection factor in an aerosol environment (aerosolized corn oil, which may be representative of a chemical or biological agent, was used). Protection factor is defined as the ratio between the challenge concentration outside the suit and the measured concentration inside the suit. The tests are described, and the calculated breakthrough times and overall protection factors are presented.

* Level A protection consists of a completely encapsulating, gas/vapor proof chemical resistant suit; a self-contained breathing apparatus (SCBA) or positive-pressure supplied-air respirator with escape SCBA, chemical resistant gloves and boots.

Blank

PREFACE

The work described in this report was authorized under the Expert Assistance (Equipment Test) Program for the U.S. Army Soldier and Biological Chemical Command (SBCCOM) Program Director for Domestic Preparedness.

The use of either trade or manufacturers' names in this report does not constitute an official endorsement of any commercial products. This report may not be cited for purposes of advertisement.

This report has been approved for public release. Registered users should request additional copies from the Defense Technical Information Center; unregistered users should direct such requests to the National Technical Information Service.

Acknowledgments

The author acknowledge John Baranoski and Janice Hannigan for conducting the tests upon which this report is based; and Frank DiPietro for managing the equipment acquisition and test scheduling necessary to accomplish the testing in a timely manner.

The author also acknowledges the technical contributions of the Expert Review Panel for Personal Protective Equipment (PPE) Testing as listed below:

Dr. Jimmy Perkins, University of Texas School of Public Health, San Antonio, TX.
Dr. Annetta Watson, Life Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN.
Dr. Ted Zellers, University of Michigan School of Public Health, Ann Arbor, MI.
Leo F. Saubier, Battelle Memorial Institute, Bel Air, MD.

The panel reviewed and commented on the test procedures, instrumentation, data analysis and presentation. Their guidance was a valuable element in the development of clear and adequate descriptions of the concepts and procedures used in these tests.

Blank

CONTENTS

EXECUTIVE SUMMARY.....	3
PREFACE.....	5
ACKNOWLEDGMENTS	5
1. INTRODUCTION	11
2. OBJECTIVES.....	11
3. TESTING AND DATA ANALYSIS.....	12
3.1 TESTING OVERVIEW	12
3.2 LIQUID CHALLENGE/VAPOR PERMEATION TESTING (AGENT SWATCH TESTING).....	12
3.2.1. Liquid Challenge/Vapor Permeation Testing Procedures.....	12
3.2.2. Liquid Challenge/Vapor Penetration Testing Analysis.....	13
3.2.3. Relationship Between Liquid Challenge/Vapor Permeation Test Results and Skin Exposure.....	14
3.2.4. Evaluation Criteria for Liquid Challenge/Vapor Permeation Test Results.....	14
3.3 AEROSOL SIMULANT TESTS.....	15
3.3.1. Test Procedures.....	15
3.3.2. Aerosol Simulant Analysis.....	16
ACRONYMS AND ABBREVIATIONS	17

APPENDIXES

A - LEVEL A SUITS CHOSEN FOR TESTING	19
B - MODIFIED STATIC DIFFUSION TEST PROCEDURE.....	21
C - AEROSOL SIMULANT TEST PROCEDURE.....	23
D - KAPPLER RESPONDER PLUS.....	25
E - KAPPLER LIFEGUARD RESPONDER.....	33
F - KAPPLER RESPONDER/NFPA ENSEMBLE.....	41
G - TRELLEBORG TRELLCHEM VPS.....	49
H - TRELLEBORG TRELLCHEM TSE.....	57
I - TRELLEBORG TRELLCHEM TBE	65
J - OVERALL TEST RESULTS	73

TABLES

<u>1. Weighting Factors For Each Sampling Area by Suit</u>	14
<u>2. Agent Breakthrough Criteria</u>	15
<u>A- 1. Level A Suits Tested</u>	19
<u>D- 1. Kappler Responder Plus - Average HD Permeation</u>	27
<u>D- 2. Kappler Responder Plus - Average GB Permeation</u>	28
<u>D- 3: Kappler Responder Plus - System Test (Aerosol Simulant) Results</u>	31
<u>D- 4. Kappler Responder Plus - Overall Test Results</u>	31
<u>E- 1. Kappler Lifeguard Responder - Average HD Permeation</u>	35
<u>E- 2. Kappler Lifeguard Responder - Average GB Permeation</u>	36
<u>E- 3. Kappler Lifeguard Responder - System Test (Aerosol Simulant) Results</u>	39
<u>E- 4. Kappler Lifeguard Responder - Overall Test Results</u>	39
<u>F- 1. Kappler Responder/NFPA Ensemble - Average HD Permeation</u>	43
<u>F- 2. Kappler Responder/NFPA Ensemble - Average GB Permeation</u>	44
<u>F- 3. Kappler Responder/NFPA Ensemble - System Test (Aerosol Simulant) Results</u>	47
<u>F- 4. Kappler Responder/NFPA Ensemble - Overall Test Results</u>	47
<u>G- 1. Trelleborg Trellchem VPS - Average HD Permeation</u>	51
<u>G- 2. Trelleborg Trellchem VPS – Average GB Permeation</u>	52
<u>G- 3. Trelleborg Trellchem VPS - System Test (Aerosol Simulant) Results</u>	55
<u>G- 4. Trelleborg Trellchem VPS - Overall Test Results</u>	55
<u>H- 1. Trelleborg Trellchem TSE - Average HD Permeation</u>	59
<u>H- 2. Trelleborg Trellchem TSE - Average GB Permeation</u>	60
<u>H- 3. Trelleborg Trellchem TSE - System Test (Aerosol Simulant) Results</u>	63
<u>H- 4. Trelleborg Trellchem TSE - Overall Test Results</u>	63
<u>I- 1. Trelleborg Trellchem TBE - Average HD Permeation</u>	67
<u>I- 2. Trelleborg Trellchem TBE - Average GB Permeation</u>	68
<u>I- 3. Trelleborg Trellchem TBE- System Test (Aerosol Simulant) Results</u>	71
<u>I- 4. Trelleborg Trellchem TBE - Overall Test Results</u>	71
<u>J- 1. Summary of Overall Results for all Level A Suits</u>	75

FIGURES

<u>D- 1: Kappler Responder Plus- Front View</u>	26
<u>D- 2: Kappler Responder Plus - Side View</u>	26
<u>D- 3: Kappler Responder Plus - Weighted Average HD Permeation</u>	29
<u>D- 4: Kappler Responder Plus - Weighted Average GB Permeation</u>	29
<u>D- 5: Kappler Responder Plus: HD Permeation by Sampling Area</u>	30
<u>D- 6: Kappler Responder Plus: GB Permeation by Sampling Area</u>	30
<u>E- 1: Kappler Lifeguard Responder - Front View</u>	34
<u>E- 2: Kappler Lifeguard Responder - Side View</u>	34
<u>E- 3: Kappler Lifeguard Responder - Weighted Average HD Permeation</u>	37
<u>E- 4: Kappler Lifeguard Responder - Weighted Average GB Permeation</u>	37
<u>E- 5: Kappler Lifeguard Responder - HD Permeation by Sampling Area</u>	38
<u>E- 6: Kappler Lifeguard Responder - GB Permeation by Sampling Area</u>	38
<u>F- 1: Kappler Responder/NFPA Ensemble - Front View</u>	42
<u>F- 2: Kappler Responder/NFPA Ensemble - Side View</u>	42
<u>F- 3: Kappler Responder/NFPA Ensemble - Weighted Average HD Permeation</u>	45
<u>F- 4: Kappler Responder/NFPA Ensemble - Weighted Average GB Permeation</u>	45
<u>F- 5: Kappler Responder/NFPA Ensemble: HD Permeation By Sampling Area</u>	46
<u>F- 6: Kappler Responder/NFPA Ensemble: GB Permeation By Sampling Area</u>	46
<u>G- 1: Trellchem VPS - Front View</u>	50
<u>G- 2: Trellchem VPS - Side View</u>	50
<u>G- 3: Trelleborg Trellchem VPS- Weighted Average HD Permeation</u>	53
<u>G- 4: Trelleborg Trellchem VPS - Weighted Average GB Permeation</u>	53
<u>G- 5: Trelleborg Trellchem VPS - HD Permeation by Sampling Area</u>	54
<u>G- 6: Trelleborg Trellchem VPS - GB Permeation by Sampling Area</u>	54
<u>H- 1: Trellchem TSE - Front View</u>	58
<u>H- 2: Trellchem TSE - Side View</u>	58
<u>H- 3: Trelleborg Trellchem TSE - Weighted Average HD Permeation</u>	61
<u>H- 4: Trelleborg Trellchem TSE - Weighted Average GB Permeation</u>	61
<u>H- 5: Trelleborg Trellchem TSE: HD Permeation by Sampling Area</u>	62
<u>H- 6: Trelleborg Trellchem TSE: GB Permeation by Sampling Area</u>	62
<u>I- 1: Trellchem TBE – Front View</u>	66
<u>I- 2: Trellchem TBE - Side View</u>	66
<u>I- 3: Trelleborg Trellchem TBE - Weighted Average HD Permeation</u>	69
<u>I- 4: Trelleborg Trellchem TBE - Weighted Average GB Permeation</u>	69
<u>I- 5: Trelleborg Trellchem TBE: HD Permeation by Sampling Area</u>	70
<u>I- 6: Trelleborg Trellchem TBE: GB Permeation by Sampling Area</u>	70
<u>J- 1: Weighted Average HD Permeation</u>	74
<u>J- 2: Weighted Average GB Permeation</u>	74

Blank

TEST RESULTS OF PHASE 2 LEVEL A SUITS TO CHALLENGE BY CHEMICAL AND BIOLOGICAL WARFARE AGENTS AND SIMULANTS: SUMMARY REPORT

1. INTRODUCTION

In 1996, Congress passed Public Law 104-201 (Defense Against Weapons of Mass Destruction Act of 1996), directing the Department of Defense (DoD) to assist other federal, state, and local agencies in enhancing preparedness for terrorist attacks using weapons of mass destruction. The DoD responded by forming the Domestic Preparedness Program that same year. One of the objectives of the Domestic Preparedness Program is to enhance emergency and hazardous material response to nuclear, biological and chemical (NBC) terrorism incidents. As part of an effective response, people who are responding to an incident will use personal protective equipment to protect them from exposure to chemical agents or biological agents. The specific personal protective equipment (PPE) that would be used by emergency responders depends upon the situation that they encounter and the PPE the responders currently possess. This information can be used by these emergency responders to establish work rules for safe work limits for Level A suits they currently possess, and can be used in deciding which Level A suits to purchase in the future. Level A protective suits are required when the greatest level of skin, respiratory, and eye protection is required, or when entering an unknown environment. Air is supplied by a pressure-demand full-facepiece self-contained breathing apparatus (SCBA) or supplied air lines.

2. OBJECTIVES

This study evaluated six different common and commercially-available Level A suits. These six different suits met the Occupational Safety and Health Administration (OSHA) description of Level A as defined in 29 Code of Federal Regulations (CFR) 1910.120, Appendix B. These suits were evaluated to assess how well they resist vapor permeation from liquid contamination¹ by chemical agents Sarin (GB) and mustard (HD) and droplet penetration by a corn-oil aerosol used to simulate biological or chemical particulates from 0.4 to 5 µm in diameter (military standard for the possible threat). This information is intended for emergency responders as an aid in evaluating Level A suits when they choose to include military chemical and biological agent protection as a criterion. The information supplements data and information provided by the suits' manufacturers. The suits are tested in new, as-received condition. The effects of aging, temperature extremes, laundering, and other factors are beyond the intended scope of this test program. These tests are conducted to assess percutaneous protection² only.

¹ Throughout this report the term permeation is used even though for some of the tests the precise mechanism of agent transfer is not determined and penetration is likely to be involved also.

² Inhalation and ocular protection are typically provided by the use of a SCBA or air-supplied respirator that covers the eyes, nose and mouth.

3. TESTING AND DATA ANALYSIS

3.1 Testing Overview

The Level A suits that are tested in this test program are listed in Appendix A. Tests include the measurement of vapor permeation of both GB and HD through material swatches. Tests are also conducted to measure the total aerosol leakage into the suits when worn as part of a complete PPE system.

3.2 Liquid Challenge/Vapor Permeation Testing (Agent Swatch Testing)

3.2.1. Liquid Challenge/Vapor Permeation Testing Procedures.

This testing is conducted to measure the actual permeation of chemical agents GB and HD through suit swatches over a 24-hr period. The test is intended to assess how well the suit materials and seams resist agent permeation. The amount of agent applied and duration of exposure do not represent any particular threat that responders would possibly encounter, but serve as a common point of reference for all test results.

The test methodology was taken from TOP 8-2-501³ and is described in Appendix B. Three swatches are taken from each of six different areas of the suit – 18 total swatches per suit design for GB and 18 more for HD. Swatches are also taken from silicone rubber (M45 mask formulation) slabs. For each test, six swatches taken from a suit and one silicone swatch are placed in test cells, one swatch per test cell. Laboratory personnel apply a predetermined liquid agent challenge (10 g/m^2) to the top surface of each swatch. Agent droplets are applied to the surface of the first swatch at time zero. Agent is then applied to the surface of each succeeding swatch at 3-min intervals. The upper chamber of each test cell is sealed. A 1.0 L/min airflow, from the test cabinet, is maintained in the lower test cell chamber beneath each swatch.

During the 24-hr test period, gas samples are taken on a sequential basis by a laboratory MINICAMS™ (OI Analytical, CMS Field Products Group, Birmingham, AL) with stream selection system (a miniaturized gas chromatograph with flame photometric detector and sampling system) from the airstream beneath each swatch. Gas sampling by the MINICAMS™ begins for the first swatch approximately 3 min following agent application. Subsequent 3-min cycles of the MINICAMS™ are composed of 2 min of desorption of collected agent vapor from the pre-concentrator tube (PCT) onto the GC column followed by 1 min of gas sampling (collection of agent vapor from the next swatch by the PCT). Sampling is done sequentially through six swatches (three from one sampling area followed by three from a second sampling area), the silicone swatch,⁴ and then three blank gas samples are taken from the test chamber to purge the sampling line before repeating the sampling sequence. The six swatches, the silicone

³ Test Operations Procedure (TOP) 8-2-501, Permeation and Penetration of Air-Permeable, Semipermeable and Impermeable Materials with Chemical Agents or Simulants (Swatch Testing). U.S. Army Dugway Proving Ground, UT. 3 March 1997, UNCLASSIFIED Report (AD A322329).

⁴ Originally, it was intended to use silicone swatches as references or controls, but it was soon found that permeation through the silicone varies too widely for it to be used for that purpose. Silicone swatches were used anyway, because they serve as a reliable source of agent vapor to assure the tester that the MINICAMS™ is responding properly during tests when little or no agent permeates the actual test swatches.

swatch, and three blanks are all sampled for the first time within the first 30 min of the test. Then the sampling sequence begins anew.

The MINICAMS™ first determines the amount of agent vapor in each gas sample. Using this result, the amount (ng) of agent vapor present in the airstream that passes beneath the swatch over the time from the previous gas sample to the current gas sample is determined by the MINICAMS™ permeation software. This amount of agent vapor is presumed to be the amount of agent vapor that has permeated the swatch over that time interval. Given the area of the test swatch, the MINICAMS™ permeation software determines the M_f at each elapsed time for each swatch. Over the 24-hr test period, a series of M_f values is calculated for each swatch. The cumulative mass of agent permeating the swatch per unit area at any elapsed time during the 24-hr test is defined as M_f .

3.2.2. Liquid Challenge/Vapor Permeation Testing Analysis.

Each suit yielded M_f data for 18 swatches for each of the two agents. For this report, the average (of three swatches) cumulative permeation (M_f) for each suit area (for example gloves) is calculated. This average is then presented, at each of the reported elapsed times, as representative of the suit's permeation resistance at that sampling area. The reported elapsed time for each sampling area is the sum of the elapsed times for the three swatches divided by three.

To estimate M_f at each elapsed time for a suit, the simplifying assumption is that the exposure is uniform over the entire suit. This permits the use of the weighting factor scheme developed by Belmonte⁵ to determine the weighted average M_f over the entire suit at each average elapsed time. The average elapsed time is the sum of the reported elapsed times for all the sampling areas divided by the number of sampling areas. The weighting factors shown in Table 1 were assigned roughly on the basis of surface area assigning a minimum assigned value of 5%. Swatches were not necessarily taken from exactly the same locations for all suits because their configurations differed. Note that not all suits have the same components. The weighted average M_f at any average elapsed time is calculated using an equation similar to the following (using the Trellchem TBE weighting factors in Table 1 for this example):

$$\text{Weighted average } M_f = 0.5(\text{suit material } M_f) + 0.15(\text{suit seam material } M_f) + 0.15(\text{visor material } M_f) + 0.1(\text{boot seam } M_f) + 0.05(\text{suit/visor interface } M_f) + 0.05(\text{zipper/material interface } M_f)$$

⁵ Belmonte, R.B., *Test Results of Level A Suits to Challenge by Chemical and Biological Warfare Agents and Simulants: Summary Report*, ERDEC-TR-513, U.S. Army Edgewood Research, Development and Engineering Center, Aberdeen Proving Ground, MD, August 1998, UNCLASSIFIED Report (AD A353013).

Table 1. Weighting Factors For Each Sampling Area by Suit

Weighting Factor, Percent, for Each Sampling Area								
Suit Model	Suit Material	Suit Seam	Visor Material	Glove Material	Suit/Visor Interface	Boot Seam	Boot Material	Zipper/Material Interface
Kappler Responder Plus (43580)	50	15	15	10	5	-	-	5
Kappler Lifeguard Responder (41550)	50	15	15	10	5	-	-	5
Kappler Responder/NFPA Ensemble (41560)	50	15	15	10	5	-	-	5
Trelleborg Trellchem VPS Suit	50	15	15	-	5	-	10	5
Trelleborg Trellchem TSE Suit	50	15	15	-	5	10	-	5
Trelleborg Trellchem TBE Suit	50	15	15	-	5	10	-	5

3.2.3. Relationship Between Liquid Challenge/Vapor Permeation Test Results and Skin Exposure.

The permeation test is designed to distinguish among these material swatches according to their permeation resistance to chemical agents. It is not intended to specifically replicate threat scenarios that may be encountered in actual use. As previously reported by Belmonte⁵, it is instructive to estimate the agent dosage ($C_{t\text{skin}}$) that would result from such a standard agent challenge as a relative indication of possible physiological effects. This is done by converting the weighted average M_f s to equivalent agent dosages. This relationship was developed by Fedele (written communication, Dr. P. Fedele, R&T Directorate, ERDEC, July 1997) and was reported by Belmonte⁵. For suit materials impermeable to airflow, the equation is:

$$\text{Agent Dosage (mg - min/m}^3) = \frac{M_f \text{ (ng/cm}^2\text{)}}{P_s, \text{ Permeability of skin to agent vapor (cm/min)}}$$

where skin permeability (P_s) is 2 cm/min for HD and 0.1 cm/min for GB. The agent dosage can then be compared to doses that are known to cause certain levels of toxicity. Skin permeability is assumed to be constant over all regions of the body.

3.2.4. Evaluation Criteria for Liquid Challenge/Vapor Permeation Test Results.

When analyzing the test results, it is useful to determine whether the data indicate that the Level A suit provides percutaneous protection over some period of time. Mustard vapor can produce erythema (reddening of the skin, certain body regions) at dosages of approximately

⁵ Belmonte, R.B., *Test Results of Level A Suits to Challenge by Chemical and Biological Warfare Agents and Simulants: Summary Report*, ERDEC-TR-513, U.S. Army Edgewood Research, Development and Engineering Center, Aberdeen Proving Ground, MD, August 1998, UNCLASSIFIED Report (AD A353013).

100 mg-min/m³, and can produce vesication (skin burns and blisters, certain body regions) at 200 mg-min/m³. Sarin vapor can produce incapacitation (twitching, convulsions or loss of consciousness) at unprotected, percutaneous dosages of approximately 8000 mg-min/m³ and can be lethal at unprotected, percutaneous dosages of 15000 mg-min/m³ where exposed persons are healthy, young, fit, and well-nourished males of approximately 70-kg mass. People who are smaller, less fit, etc., may exhibit adverse effects at lower doses ($C_{it\text{skin}}$). The simplifying assumption was that the suit was exposed to a uniform liquid GB challenge over its entire surface, resulting in a uniform exposure of all body regions to GB vapor. Therefore, the amount of agent per unit area (weighted average M_f) necessary to permeate the suit to produce a predetermined physiological effect was estimated by using each of the above dosages and the appropriate skin permeability (P_s). These values are used in the graphs of weighted average M_f versus time given in Appendixes D through I and summarized in Table 2. The breakthrough dosages are assumed to be the HD dosage that produces erythema (100 mg-min/m³) and the GB dosage that produces incapacitation (8000 mg-min/m³). A breakthrough time is the time when the weighted average M_f equals the breakthrough dosage criterion.

Table 2. Agent Breakthrough Criteria

Agent	Breakthrough Dosage (mg-min/m ³)	Physiological Effect	Skin Permeability (P_s), (cm/min)	Breakthrough M_f , (ng/cm ²)
HD	100	Erythema	2	200
HD	200	Vesication	2	400
GB	8000	Incapacitation	0.1	800
GB	15000	Lethality	0.1	1500

3.3 Aerosol Simulant Tests

3.3.1. Test Procedures.

The testing is conducted to determine leakage of a challenge corn-oil aerosol (physical simulant of a biological or chemical agent aerosol) into a suit ensemble while people are wearing ensembles of different sizes. Volunteers dressed in Level A suits with SCBA enter a chamber with aerosol simulant. Instrumentation measures any aerosol leakage (penetration) into the suit through gaps between ensemble components. During the test, the people in the suits perform standardized movements. A brief description of the test and movements made by the people during the test are given in Appendix C. Six different ensembles, listed in Appendix A, were tested. Eight suits of each design were worn by 12 volunteers on each of two days (not necessarily the same 12 on both days), for a total of 24 trials for each suit design. Thus, not all of the volunteers or suit replicates were used in equal numbers of trials to accomplish the tests.

From this test a protection factor (PF) is derived. In simplest terms, PF is a measure of the challenge concentration outside the suit divided by the concentration inside the suit ensemble. For example, if the concentration of aerosol inside the suit ensemble is found to be 1/10th the value of the average concentration outside the suit ensemble, the PF is equal to 10.

3.3.2. Aerosol Simulant Analysis.

Samples of aerosol are taken continuously at the visor and upper arm within the suit and their concentrations are measured by laser photometry, recorded in a computer file and displayed continuously on a computer monitor. These sampling locations were selected as being the most likely locations for aerosol leakage to occur. So this is thought to be worst case and the PF is a worst case PF.

The PF data are presented based upon predetermined PF pass levels, ranging from 10 to 100,000 (i.e., at each pass level the number of failing and passing suits is recorded). The higher the percentage of test occasions that passes at a given PF, the greater the probability that the suit will provide that level of protection in use.

ACRONYMS and ABBREVIATIONS

Ct	Vapor exposure, product of vapor concentration (mg/m ³) and time (minutes)
C _t t _{skin} cm ²	Vapor exposure to skin Square centimeters
°F	Temperature in degrees Fahrenheit
delta p	Differential pressure
DoD	Department of Defense
ECBC	U.S. Army Edgewood Chemical Biological Center
ERDEC	U.S. Army Edgewood Research, Development and Engineering Center
g	Gram
GB	Sarin, Isopropylmethylphosphonofluoridate
HD	Sulfur Mustard; 2,2'-Dichlorodiethylsulfide
L	Liter
M _f m ²	Cumulative mass permeation through the fabric Square meters
m ³	Cubic meters
mg	Milligram
µL	Microliter
ng	Nanogram
NBC	Nuclear, Biological and Chemical
OSHA	Occupational Safety and Health Administration
PCT	Pre-concentrator tube
PF	Protection Factor
PPE	Personal Protective Equipment
P _s	Skin permeability
RH	Relative Humidity
SCBA	Self-Contained Breathing Apparatus
TOP	Test Operations Procedure

Blank

Appendix A -
Level A Suits Chosen for Testing

Table A- 1. Level A Suits Tested

Model	Manufacturer	Address
Kappler Responder Plus (43580)	Kappler Protective Apparel and Fabrics	Guntersville, AL
Kappler Lifeguard Responder (41550)	Kappler Protective Apparel and Fabrics	Guntersville, AL
Kappler Responder/NFPA Ensemble (41560)	Kappler Protective Apparel and Fabrics	Guntersville, AL
Trelleborg Trellchem VPS Suit	Trelleborg Viking, Inc.	Ystad, Sweden
Trelleborg Trellchem TSE Suit	Trelleborg Viking, Inc	Ystad, Sweden
Trelleborg Trellchem TBE Suit	Trelleborg Viking, Inc.	Ystad, Sweden

Blank

Appendix B -

Modified Static Diffusion Test Procedure

MODIFIED STATIC DIFFUSION TEST

This test procedure was adapted from Test Operations Procedure (TOP) 8-2-501, Permeation and Penetration of Air-Permeable, Semipermeable and Impermeable Materials with Chemical Agents or Simulants (Swatch Testing). U.S. Army Dugway Proving Ground, UT. 3 March 1997, UNCLASSIFIED Report (AD A322329). The test procedure was entitled “Semipermeable and Impermeable Materials Static Diffusion Penetration Testing (Liquid Agent Challenge/Vapor Penetration; delta p = 0, Single Flow Test)”. The following procedure was used:

1. Upon receipt of a suit, all available information concerning the suit will be recorded; date of manufacture, lot number, serial number, materials of construction, etc.
2. From each suit, three each 1 and 15/16-in diameter material swatches will be taken for mustard (HD) and a like number taken for sarin (GB). Depending upon the suit configuration, 3 seam swatches (same diameter) will be taken plus triplicate swatches of other flat components such as visor, gloves, suit/visor interface and zipper/material interface for HD and an equal number for GB. Each swatch will be placed in an airtight bag and given a unique serial number, which will be placed on the bag. A list of serial numbers will be kept with the swatches. Alternatively, the swatches for each day's test will be cut from the suit and placed in the environmental chamber for conditioning. Sample identification will accompany each swatch.
3. The environmental chamber will be controlled at a temperature of 90 +/- 2 °F, and the maximum achievable relative humidity (RH) without occurrence of condensation (normally 50% +/- 10% RH). The temperature and RH readings will be checked weekly with a calibrated meter. The test cell air will be drawn from the chamber air. The TOP 8-2-501 specifies that a system control and data acquisition system will be used, but this system will not be used due to budget constraints. The temperature and RH will be recorded in a computer file. Flow rates will be manually recorded. The TOP 8-2-501 specifies that differential pressure monitoring will be done but differential pressure gages will not be used due to budget constraints.
4. The TOP test cell will be used. When assembling, the cell lugs will be tightened by hand to finger tight. The flow rate beneath each swatch will be 1 L/min, which will be controlled by a linear mass flow controller. The flows will be checked with a calibrated test meter weekly. Each test cell will be checked for leaks after assembly by connecting it to the vacuum source and checking that the inlet flow is the same as the outlet flow on the mass flow controller. If the flows don't match, the test cell will be disassembled, adjustments made, the test cell reassembled and flows rechecked.
5. The TOP 8-2-501 specifies that positive control and negative control swatches will be used, but they will not be used due to budgetary and schedule limitations. The swatches will be preconditioned for at least 2 hr and will be monitored by MINICAMS for at least one cycle prior to agent application. Eighty-mil silicone will be used, one for each test (six suit swatches and one silicone swatch).
6. Agents GB and HD will be used. The contamination density will be 10 g/m² (8 each 1 µL HD droplets or 10 each 1 µL GB droplets). A robotic agent application system is not available. The agent will be applied using the click/touch method with a repeating dispenser.

7. Seven swatches will be tested at once. MINICAMS with stream selection system will monitor vapor penetration with a 3-min cycle. There will be three sampling intervals following the silicone during which chamber air will be sampled. Each swatch will be sampled once every 30 min. The MINICAMS will be standardized weekly with a range of agent standards; concentrations will normally range from 1 ng/ μ L to 100 ng/ μ L.

8. The test length will be 24 hr.

9. The test cells and o-rings will be aerated between uses. No other cleaning method will be used.

10. The data to be reported are cumulative permeation (ng/cm^2) at various elapsed times (minutes) for each swatch. The elapsed time for each swatch is the time from agent contamination. All recorded data will be placed in laboratory notebooks and one technical report per suit will be drafted at the conclusion of this effort.

Appendix C -

Aerosol Simulant Test Procedure

To properly test suits with statistical significance, eight suit ensembles of each model are provided to the Mask Fit Test Facility for examination. Each ensemble is new and inspected as received. The suit ensembles include relevant accessory equipment such respirators that are worn with the suits, gloves, boots, and any other equipment that is necessary for chemical agent use. The suit ensembles are run on at least 10 different subjects with at least 22 trials. The eight suits are reused to achieve the 22 or more trials. Sampling of suits is done at the visor and upper arm for each trial.

Exercise routine for all suits is as follows:

Phase 1 (Pre-Operational):

- 1) standing still, normal breathing
- 2) bending forward and touching toes
- 3) jogging in place
- 4) raising arms above head and looking upward
- 5) bending knees and squatting
- 6) crawling on hands and knees
- 7) torso twists with hands folded on chest
- 8) standing still, normal breathing

Phase 2 (Operational):

- 1) climb step ladder
- 2) move 3 lb boxes from table to floor
- 3) rest
- 4) roll walls and ceiling
- 5) bag clothes
- 6) rest
- 7) loosen bolts
- 8) move 3 lb boxes from floor to table

Note: The phase 1 (pre-operational) exercises are performed for 1 min each for a total of 8 min. The phase 2 (operational) exercises are performed for 4 min each for a total of 40 min.

Blank

Appendix D -
Kappler Responder Plus



**Figure D- 1: Kappler Responder Plus -
Front View**

[picture not available]

**Figure D- 2: Kappler Responder Plus -
Side View**

Table D- 1. Kappler Responder Plus - Average HD Permeation

Kappler Responder Plus 43580													
Time (min)	Suit Material	Time (min)	Suit Seam	Time (min)	Visor Material	Time (min)	Glove	Time (min)	Suit/Visor Interface	Time (min)	Zipper/Material Interface	Average Time (min)	Weighted Average M _r
5	1	14	3	4	1	6	2	13	3	15	5	10	2
35	8	44	14	34	18	36	10	43	16	45	21	40	12
65	12	74	23	64	34	66	13	73	28	75	52	70	20
95	12	104	29	94	49	96	21	103	40	105	212	100	32
125	12	134	30	124	65	126	30	133	52	135	607	130	56
155	12	164	30	154	83	156	41	163	66	165	1164	160	89
185	12	194	30	184	103	186	55	193	79	195	1775	190	124
215	12	224	30	214	125	216	71	223	94	225	2417	220	162
245	12	254	30	244	149	246	89	253	110	255	3096	250	202
275	12	284	30	274	175	276	107	283	126	285	3834	280	245
305	12	314	30	304	202	306	125	313	143	315	4640	310	293
335	12	344	30	334	231	336	143	343	160	345	5519	340	343
365	12	374	30	364	261	366	160	373	179	375	6490	370	399
395	23	404	39	394	290	396	178	403	197	405	7559	400	467
425	46	434	55	424	320	426	197	433	216	435	8723	430	546
455	67	464	63	454	351	456	217	463	235	465	9980	460	628
485	86	494	71	484	381	486	239	493	253	495	11327	490	714
515	106	524	79	514	410	516	262	523	272	525	12755	520	804
545	123	554	83	544	439	546	286	553	291	555	14243	550	895
575	138	584	87	574	468	576	312	583	309	585	15782	580	988
605	154	614	94	604	497	606	339	613	327	615	17371	610	1084
635	171	644	104	634	524	636	367	643	345	645	19004	640	1184
665	187	674	112	664	551	666	396	673	363	675	20679	670	1284
695	201	704	118	694	577	696	425	703	380	705	22390	700	1385
725	212	734	121	724	601	726	455	733	396	735	24122	730	1486
755	220	764	123	754	626	756	486	763	412	765	25871	760	1585
785	226	794	124	784	649	786	519	793	428	795	27639	790	1684
815	232	824	126	814	672	816	552	823	444	825	29423	820	1784
845	237	854	126	844	694	846	585	853	460	855	31220	850	1884
875	241	884	127	874	716	876	620	883	475	885	33022	880	1984
905	247	914	128	904	737	906	654	913	489	915	34817	910	2084
935	250	944	128	934	757	936	688	943	504	945	36612	940	2182
965	250	974	128	964	777	966	722	973	518	975	38408	970	2279
995	254	1004	130	994	796	996	756	1003	532	1005	40201	1000	2378
1025	259	1034	133	1024	814	1026	789	1033	546	1035	41993	1030	2478
1055	263	1064	135	1054	832	1056	822	1063	559	1065	43782	1060	2576
1085	266	1094	135	1084	850	1086	855	1093	573	1095	45570	1090	2673
1115	268	1124	135	1114	867	1116	886	1123	586	1125	47352	1120	2770
1145	268	1154	135	1144	884	1146	916	1153	599	1155	49127	1150	2865
1175	268	1184	135	1174	900	1176	946	1183	611	1185	50891	1180	2959
1205	268	1214	135	1204	915	1206	975	1213	623	1215	52647	1210	3052
1235	268	1244	135	1234	930	1236	1004	1243	635	1245	54403	1240	3146
1265	268	1274	135	1264	945	1266	1031	1273	645	1275	56159	1270	3239
1295	268	1304	135	1294	960	1296	1057	1303	655	1305	57911	1300	3332
1325	268	1334	135	1324	974	1326	1082	1333	666	1335	59653	1330	3424
1355	268	1364	135	1354	988	1356	1107	1363	677	1365	61384	1360	3516
1385	268	1394	135	1384	1001	1386	1129	1393	688	1395	63102	1390	3607
1415	268	1424	135	1414	1015	1416	1152	1423	699	1425	64807	1420	3697

Note 1: The time given for each sampling area is the average of the elapsed times for the three swatches tested per sampling area.

Note 2: The average time is the sum of the times given for each sampling area divided by the number of sampling areas.

Note 3: Weighted average M_r = 0.5(Suit Matl M_r) + 0.15(Suit Seam M_r) + 0.15(Visor Matl M_r) + 0.1(Glove M_r) + 0.05(Suit/Visor Interface M_r) + 0.05(Zipper/Matl Interface M_r).

Table D- 2. Kappler Responder Plus - Average GB Permeation

Kappler Responder Plus 43580													
Time (min)	Suit Material	Time (min)	Suit Seam	Time (min)	Visor Material	Time (min)	Glove	Time (min)	Suit/Visor Interface	Time (min)	Zipper/Material Interface	Average Time (min)	Weighted Average M _f
5	0	14	0	3	0	4	0	12	1	13	0	9	0
35	5	44	788	33	7	34	4	42	1380	43	3	39	191
65	20	74	2425	63	28	64	11	72	4220	73	14	69	591
95	47	104	4130	93	58	94	22	102	7156	103	40	99	1014
125	79	134	5835	123	89	124	33	132	10106	133	115	129	1442
155	109	164	7519	153	119	154	43	162	13047	163	298	159	1872
185	138	194	9184	183	149	184	55	192	15952	193	666	189	2305
215	167	224	10827	213	177	214	67	222	18784	223	1293	219	2744
245	193	254	12447	243	204	244	81	252	21526	253	2227	249	3190
275	218	284	14038	273	230	274	97	282	24190	283	3489	279	3643
305	242	314	15591	303	255	304	115	312	26789	313	5063	309	4102
335	264	344	17104	333	279	334	134	342	29305	343	6921	339	4564
365	286	374	18566	363	302	364	156	372	31757	373	9031	369	5028
395	306	404	19966	393	324	394	179	402	34157	403	11382	399	5492
425	326	434	21307	423	345	424	205	432	36484	433	13950	429	5953
455	345	464	22599	453	365	454	232	462	38718	463	16649	459	6409
485	363	494	23843	483	386	484	260	492	40864	493	19428	489	6857
515	381	524	25040	513	405	514	289	522	42935	523	22283	519	7297
545	398	554	26184	543	424	544	318	552	44914	553	25195	549	7727
575	415	584	27250	573	442	574	348	582	46830	583	28109	579	8143
605	431	614	28263	603	460	604	378	612	48694	613	31035	609	8548
635	448	644	29243	633	477	634	406	642	50485	643	33941	639	8944
665	464	674	30198	663	494	664	433	672	52219	673	36804	669	9330
695	480	704	31115	693	511	694	460	702	53902	703	39634	699	9707
725	496	734	31990	723	527	724	487	732	55531	733	42441	729	10073
755	510	764	32837	753	542	754	514	762	57101	763	45210	759	10429
785	525	794	33645	783	557	784	540	792	58601	793	47937	789	10774
815	539	824	34429	813	572	814	565	822	60036	823	50628	819	11109
845	553	854	35183	843	587	844	590			853	53258	848	8364
875	567	884	35912	870	598	874	614			883	55847	877	8614
905	581			897	607	904	638			913	58358	905	3363
932	591			924	617	934	662			943	60817	933	3495
959	600			951	625	964	685			973	63265	962	3626
986	608			978	634	994	707			1003	65666	990	3753
1013	617			1005	642	1024	729			1033	68000	1019	3878
1040	625			1032	651	1054	750			1063	70280	1047	3999
1067	633			1059	658	1084	771			1093	72509	1076	4118
1094	641			1086	666	1114	792			1123	74670	1104	4233
1121	648			1113	674	1144	812			1153	76766	1133	4345
1148	656			1140	681	1174	830			1183	78816	1161	4454
1175	663			1167	689	1204	847			1213	80814	1190	4560
1202	670			1194	696	1234	865			1243	82754	1218	4664
1229	677			1221	703	1264	882			1273	84657	1247	4765
1256	684			1248	709	1294	898						
1283	691			1275	716	1321	912						
1310	697			1302	722	1348	927						
1337	704			1329	729	1375	941						
1364	710			1355	735	1402	954						

Note 1: The time given for each sampling area is the average of the elapsed times for the three swatches tested per sampling area.

Note 2: The average time is the sum of the times given for each sampling area divided by the number of sampling areas.

Note 3: Weighted average M_f = 0.5(Suit Matl M_f) + 0.15(Suit Seam M_f) + 0.15(Visor Matl M_f) + 0.1(Glove M_f) + 0.05(Suit/Visor Interface M_f) + 0.05(Zipper/Matl Interface M_f).

Kappler Responder Plus 43580

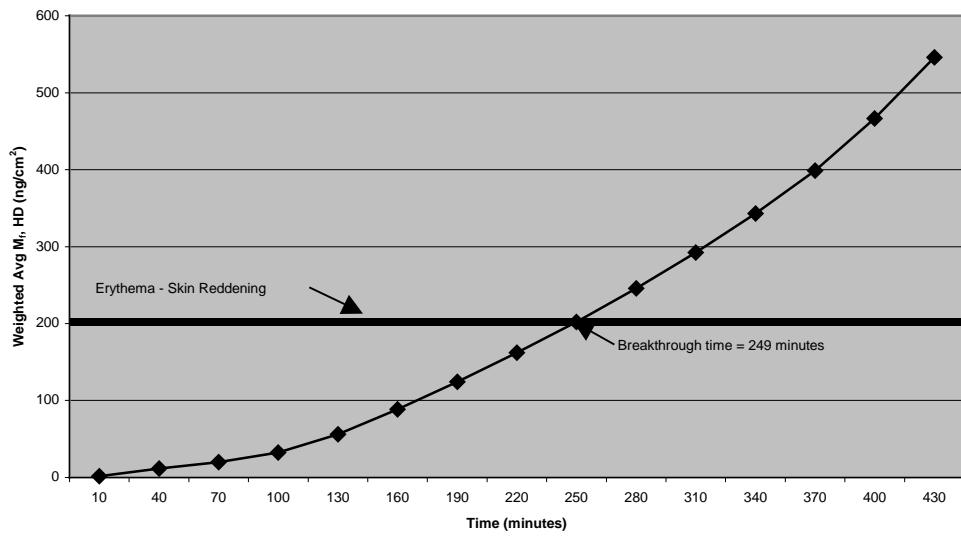


Figure D- 3: Kappler Responder Plus - Weighted Average HD Permeation

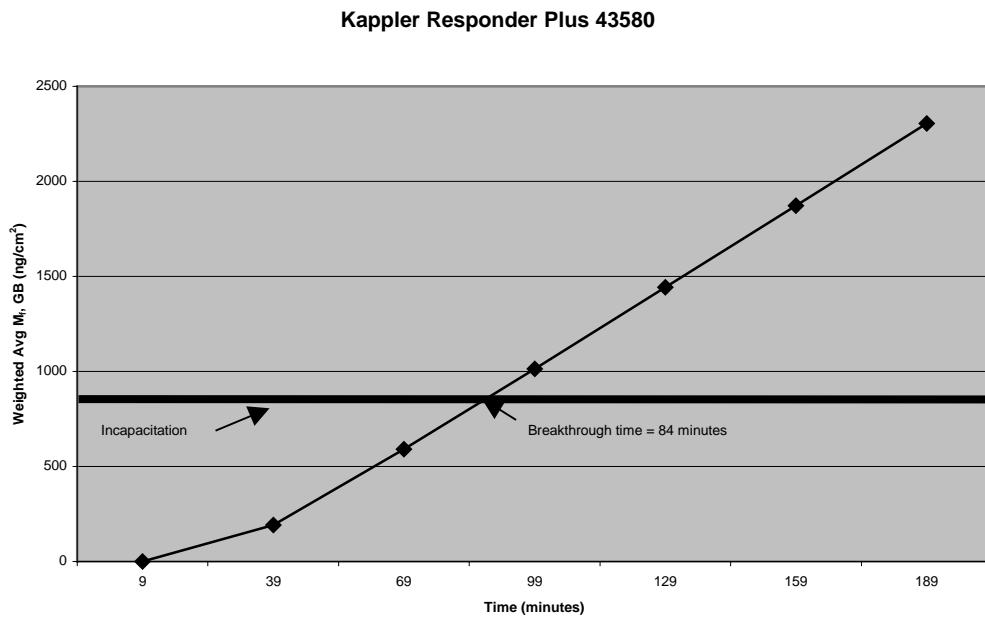


Figure D- 4: Kappler Responder Plus - Weighted Average GB Permeation

Kappler Responder Plus 43580

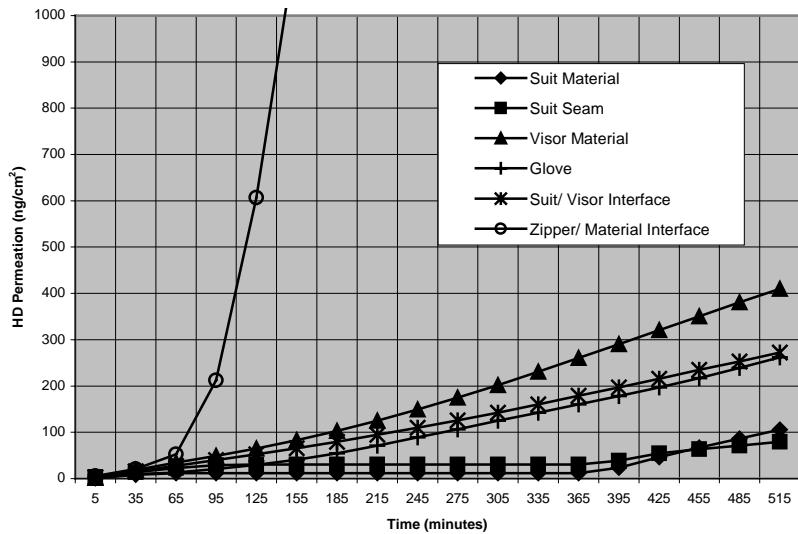


Figure D- 5: Kappler Responder Plus: HD Permeation by Sampling Area

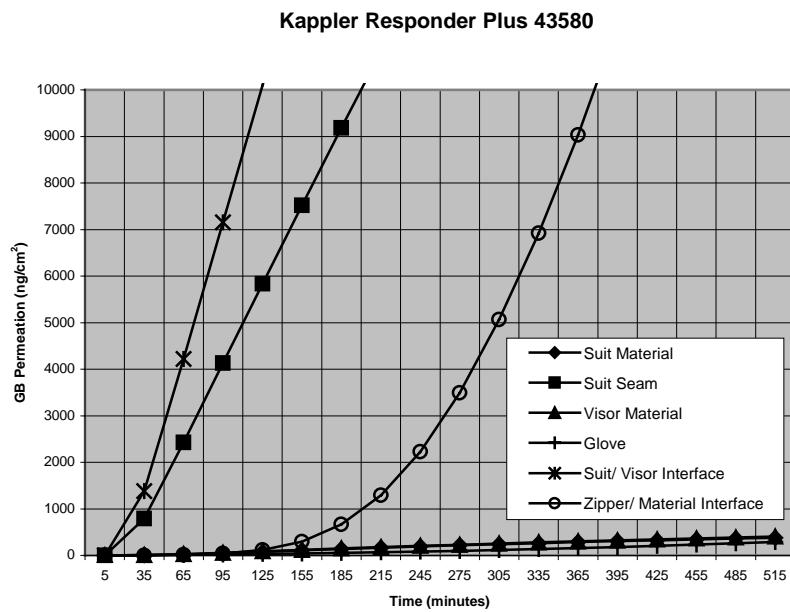


Figure D- 6: Kappler Responder Plus: GB Permeation by Sampling Area

Table D- 3: Kappler Responder Plus - System Test (Aerosol Simulant) Results

PF	Visor Region and Upper Arm, Combined					
	Pre-Operational Exercises			Operational Exercises		
	No. of Occasions	Cumulative Rate, Percent	Cumulative Pass Rate, Percent	No. of Occasions	Cumulative Rate, Percent	Cumulative Pass Rate, Percent
0	0	0	100	0	0	100
10	0	0	100	0	0	100
50	0	0	100	0	0	100
100	0	0	100	0	0	100
150	0	0	100	0	0	100
500	7	15.2	84.8	2	4.4	96.6
1000	9	34.8	65.2	3	10.9	89.1
1667	6	47.8	52.2	4	19.6	80.4
2000	2	52.2	47.8	3	26.1	73.9
5000	17	89.1	10.9	21	71.7	28.3
6667	5	100	0	2	76.1	23.9
10000	0	100	0	7	91.3	8.7
20000	0	100	0	4	100	0
50000	0	100	0	0	100	0
100000	0	100	0	0	100	0
No. of Trials	46			46		

Table D- 4. Kappler Responder Plus - Overall Test Results

Breakthrough Time (minutes)		Aerosol PF Pass Rate at PF Equal to:			Exercise Phase
Incapacitation	Erythema	100	1000	2000	
GB	HD				
84	249	100 100	65.2 89.1	47.8 73.9	Pre-Operational Operational

Blank

Appendix E -
Kappler Lifeguard Responder



**Figure E- 1: Kappler Lifeguard Responder -
Front View**



**Figure E- 2: Kappler Lifeguard Responder -
Side View**

Table E- 1. Kappler Lifeguard Responder - Average HD Permeation

Kappler Lifeguard Responder 41550													
Time (min)	Suit Material	Time (min)	Suit Seam	Time (min)	Visor Material	Time (min)	Glove	Time (min)	Suit/Visor Interface	Time (min)	Zipper/Material Interface	Average Time (min)	Weighted Average M _f
4	0	13	0	5	0	5	4	14	0	14	19	9	1
34	0	43	0	35	0	35	70	44	0	44	98	39	12
64	0	73	0	65	0	65	135	74	0	74	192	69	23
94	0	103	0	95	0	95	201	104	0	104	443	99	42
124	3	133	0	125	3	125	273	134	0	134	1073	129	83
154	12	163	1	155	10	155	354	164	2	164	2163	159	151
184	25	193	7	185	20	185	446	194	6	194	3681	189	245
214	41	223	15	215	32	215	544	224	13	224	5583	219	362
244	58	253	25	245	45	245	648	254	19	254	7849	249	498
274	75	283	34	275	59	275	757	284	27	284	10431	279	650
304	91	313	43	305	74	305	870	314	34	314	13296	309	817
334	108	343	53	335	88	335	985	344	42	344	16437	339	998
364	124	373	62	365	102	365	1102	374	49	374	19824	369	1190
394	140	403	71	395	116	395	1222	404	57	404	23426	399	1394
424	155	433	80	425	129	425	1344	434	64	434	27199	429	1606
454	170	463	89	455	141	455	1469	464	71	464	31119	459	1826
484	184	493	98	485	153	485	1596	494	76	494	35174	489	2052
514	198	523	106	515	164	515	1725	524	79	524	39321	519	2282
544	211	553	109	545	173	545	1856	554	80	554	43540	549	2515
574	224	583	112	575	181	575	1988	584	80	584	47851	579	2751
604	236	613	116	605	187	605	2122	614	80	614	52213	609	2990
634	247	643	119	635	191	635	2256	644	80	644	56615	639	3230
664	257	673	120	665	194	665	2391	674	80	674	61078	669	3473
694	266	703	121	695	196	695	2528	704	80	704	65582	699	3716
724	269	733	121	725	198	725	2664	734	80	734	70088	729	3957
754	269	763	121	755	198	755	2801	764	80	764	74578	759	4196
784	269	793	121	785	199	785	2937	794	80	794	79030	789	4432
814	269	823	121	815	200	815	3073	824	80	824	83465	819	4667
844	269	853	121	845	200	845	3209	854	80				
874	271	883	121	875	200	872	3327	884	80				
904	275	913	121	905	200	899	3441	914	80				
934	282	943	121	935	200	926	3556	944	80				
964	289	973	121	965	200	950	3654	974	80				
994	295	1003	121	995	201	974	3746	1004	80				
1024	301	1033	121	1025	205	998	3837	1034	80				
1054	306	1063	121	1055	209	1022	3928	1064	80				
1084	310	1093	121	1085	213	1046	4022	1094	80				
1114	312	1123	121	1115	218	1070	4118	1124	80				
1144	315	1153	121	1145	230	1094	4218	1154	80				
1174	317	1183	121	1175	247	1115	4307	1184	80				
1204	318	1213	121	1205	267	1136	4398	1214	81				
1234	318	1243	121	1235	292	1157	4493	1244	82				
1264	318	1273	121	1265	320	1175	4571	1274	84				
1294	318	1303	121	1295	353	1193	4645	1304	87				
1324	318	1333	121	1325	390	1211	4721	1334	89				
1354	318	1363	121	1355	431	1229	4799	1364	92				
1384	318	1393	121	1385	476	1247	4880	1394	94				
1414	318	1423	121	1415	525	1265	4964	1424	96				

Note 1: The time given for each sampling area is the average of the elapsed times for the three swatches tested per sampling area.

Note 2: The avg. time is the sum of the times given for each sampling area divided by the number of sampling areas.

Note 3: Weighted average M_f = 0.5(Suit Matl M_f) + 0.15(Suit Seam M_f) + 0.15(Visor Matl M_f) + 0.1(Glove M_f) + 0.05(Suit/Visor Interface M_f) + 0.05(Zipper/Matl Interface M_f).

Table E- 2. Kappler Lifeguard Responder - Average GB Permeation

Kappler Lifeguard Responder 41550													
Time (min)	Suit Material	Time (min)	Suit Seam	Time (min)	Visor Material	Time (min)	Glove	Time (min)	Suit/Visor Interface	Time (min)	Zipper/Material Interface	Average Time (min)	Weighted Average Mf
5	0	14	0	4	0	4	1	13	1	13	2	9	0
35	72	44	112	34	4	34	6	43	99	43	92	39	63
65	252	74	346	64	12	64	12	73	316	73	267	69	210
95	458	104	577	94	18	94	19	103	552	103	449	99	370
125	635	134	776	124	24	124	25	133	774	133	669	129	512
155	783	164	947	154	30	154	32	163	980	163	1007	159	640
185	911	194	1100	184	36	184	39	193	1177	193	1596	189	768
215	1023	224	1240	214	41	214	46	223	1365	223	2526	219	903
245	1125	254	1368	244	45	244	54	253	1544	253	3759	249	1045
275	1219	284	1489	274	49	274	62	283	1712	283	5249	279	1194
305	1307	314	1603	304	53	304	71	313	1875	313	7000	309	1353
335	1389	344	1711	334	55	334	81	343	2032	343	8999	339	1519
365	1467	374	1815	364	57	364	92	373	2185	373	11244	369	1695
395	1540	404	1914	394	60	394	104	403	2332	403	13702	399	1878
425	1611	434	2009	424	63	424	116	433	2474	433	16333	429	2068
455	1678	464	2101	454	67	454	129	463	2613	463	19117	459	2264
485	1743	494	2189	484	70	484	142	493	2749	493	22008	489	2462
515	1805	524	2274	514	71	514	156	523	2882	523	24970	519	2662
545	1864	554	2356	544	73	544	170	553	3012	553	28023	549	2865
575	1921	584	2436	574	75	574	185	583	3139	583	31189	579	3072
605	1977	614	2513	604	77	604	201	613	3263	613	34451	609	3283
635	2031	644	2588	634	78	634	216	643	3383	643	37784	639	3495
665	2082	674	2661	664	79	664	232	673	3501	673	41158	669	3708
695	2132	704	2731	694	80	694	248	703	3615	703	44584	699	3922
725	2180	734	2799	724	82	724	264	733	3728	733	48071	729	4139
755	2228	764	2866	754	84	754	280	763	3838	763	51599	759	4356
785	2273	794	2931	784	85	784	297	793	3947	793	55155	789	4574
815	2318	824	2995	814	87	814	313	823	4054	823	58727	819	4791
845	2360	854	3056	844	89	844	330	853	4159	853	62305	849	5008
875	2401	884	3114	874	90	874	347	883	4261	883	65839	879	5221
905	2440	914	3171	904	92	904	364	913	4364	913	69333	909	5431
935	2479	944	3228	934	94	934	381	943	4465	943	72795	939	5639
965	2516	974	3283	964	95	964	398	973	4564	973	76219	969	5844
995	2553	1004	3336	994	95	994	414	1003	4663	1003	79594	999	6046
1025	2589	1034	3388	1024	97	1024	431	1033	4759	1033	82935	1029	6245
1055	2623	1064	3438	1054	99	1054	447	1063	4855	1063	86251	1059	6442
1085	2656	1094	3488	1084	100	1084	463	1093	4949	1093	89499	1089	6635
1115	2689	1124	3536	1114	102	1114	479	1123	5043	1123	92707	1119	6826
1145	2723	1154	3584	1144	104	1144	495	1153	5136				
1175	2756	1184	3634	1174	105	1171	509	1183	5229				
1205	2791	1214	3685	1204	106	1195	519	1213	5321				
1235	2825	1244	3736	1234	107	1219	529	1243	5413				
1265	2859	1274	3786	1264	109	1243	537	1273	5504				
1295	2892	1304	3836	1294	109	1267	545	1303	5593				
1325	2924	1334	3884	1324	110	1291	554	1333	5681				
1355	2955	1364	3931	1354	112	1315	561	1363	5769				
1385	2986	1394	3975	1384	113	1339	569	1393	5856				
1415	3017	1424	4020	1414	113	1363	576	1423	5940				

Note 1: The time given for each sampling area is the average of the elapsed times for the three swatches tested per sampling area.

Note 2: The avg. time is the sum of the times given for each sampling area divided by the number of sampling areas.

Note 3: Weighted average $M_f = 0.5(\text{Suit Matl } M_f) + 0.15(\text{Suit Seam } M_f) + 0.15(\text{Visor Matl } M_f) + 0.1(\text{Glove } M_f) + 0.05(\text{Suit/Visor Interface } M_f) + 0.05(\text{Zipper/Matl Interface } M_f)$.

Kappler Lifeguard Responder 41550

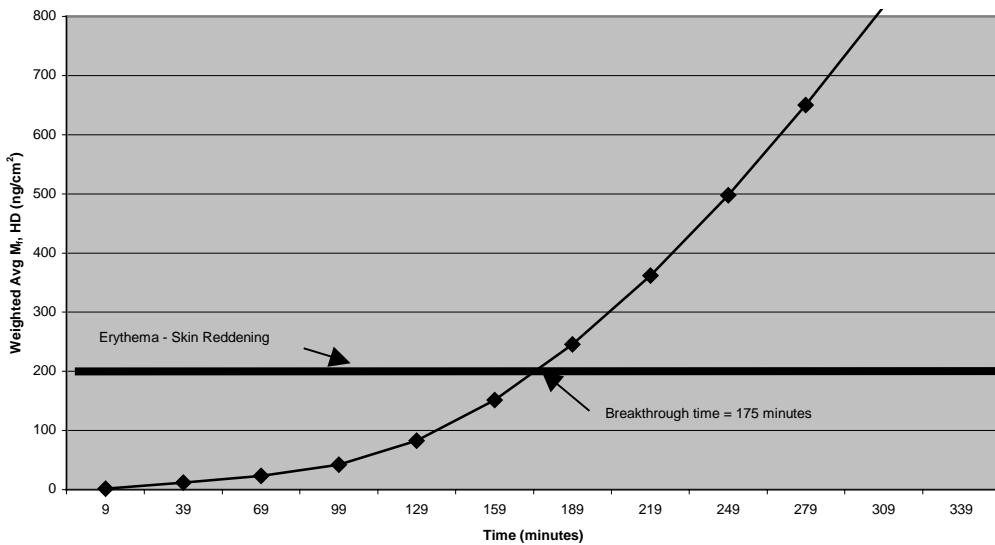


Figure E- 3: Kappler Lifeguard Responder - Weighted Average HD Permeation

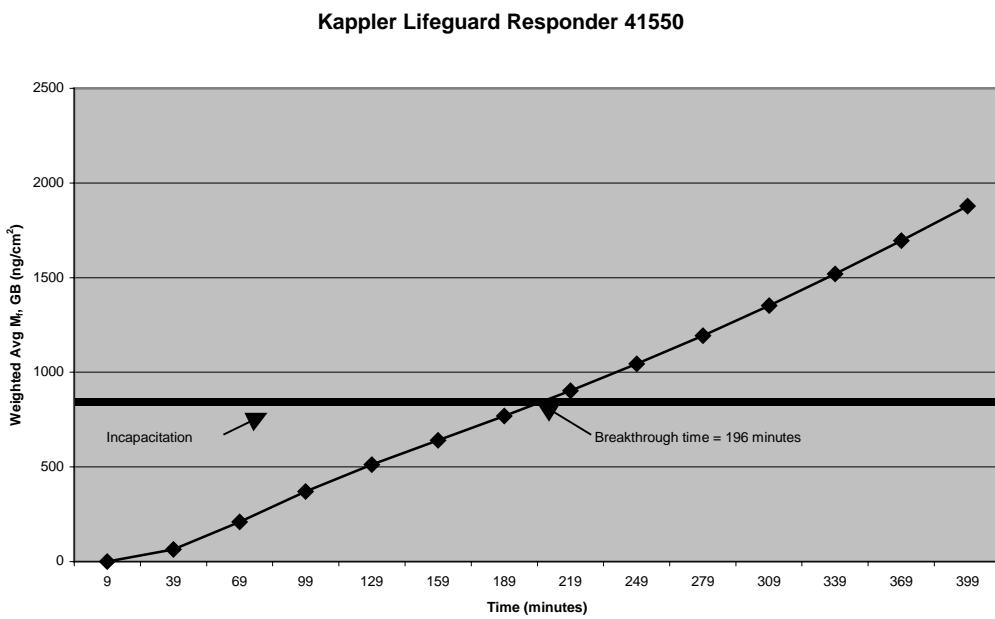


Figure E- 4: Kappler Lifeguard Responder - Weighted Average GB Permeation

Kappler Lifeguard Responder 41550

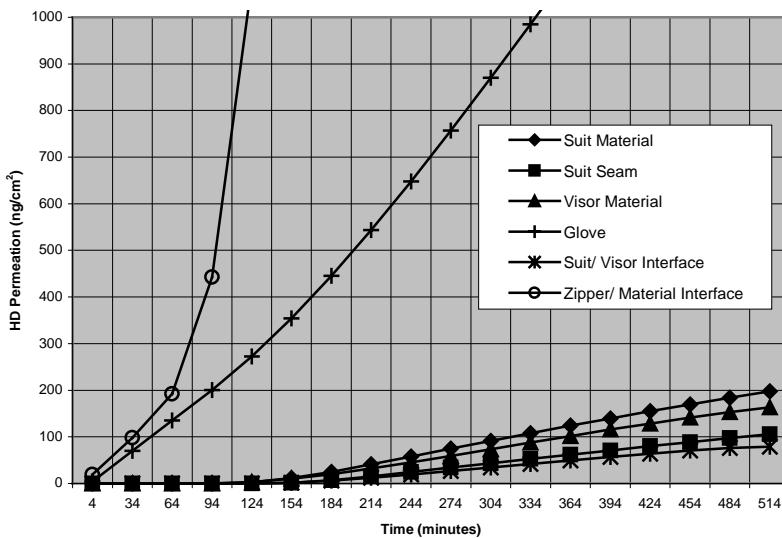


Figure E- 5: Kappler Lifeguard Responder - HD Permeation by Sampling Area

Kappler Lifeguard Responder 41550

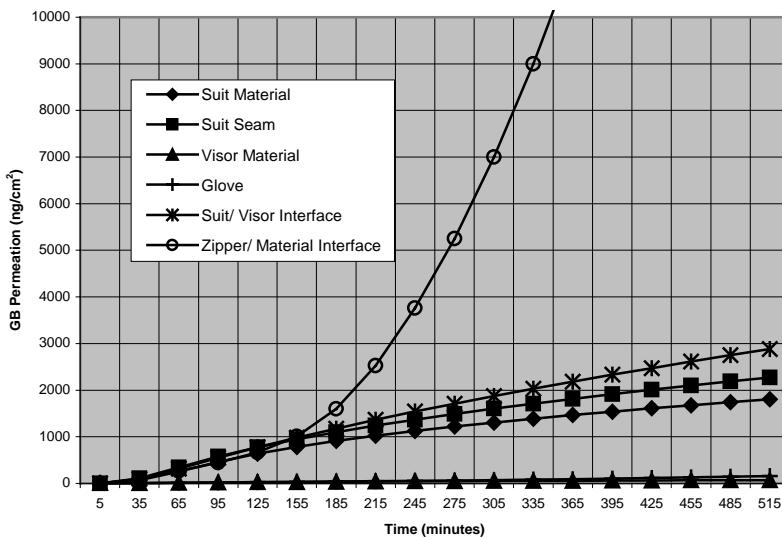


Figure E- 6: Kappler Lifeguard Responder - GB Permeation by Sampling Area

Table E- 3. Kappler Lifeguard Responder - System Test (Aerosol Simulant) Results

PF	Visor Region and Upper Arm, Combined					
	Pre-Operational Exercises			Operational Exercises		
	No. of Occasions	Cumulative Rate, Percent	Cumulative Pass Rate, Percent	No. of Occasions	Cumulative Rate, Percent	Cumulative Pass Rate, Percent
0	0	0	100	0	0	100
10	0	0	100	0	0	100
50	0	0	100	0	0	100
100	0	0	100	0	0	100
150	0	0	100	0	0	100
500	6	12.5	87.5	2	4.2	95.8
1000	10	33.3	66.7	11	27.1	72.9
1667	12	58.3	41.7	7	41.7	58.3
2000	6	70.8	29.2	6	54.2	45.8
5000	12	95.8	4.2	19	93.8	6.2
6667	2	100	0	0	93.8	6.2
10000	0	100	0	1	95.8	4.2
20000	0	100	0	1	97.9	2.1
50000	0	100	0	1	100	0
100000	0	100	0	0	100	0
No. of Trials	48			48		

Table E- 4. Kappler Lifeguard Responder - Overall Test Results

Breakthrough Time (minutes)		Aerosol PF Pass Rate at PF Equal to:			Exercise Phase
Incapacitation	Erythema	100	1000	2000	
GB	HD	100	1000	2000	
196	175	100	66.7	29.2	Pre-Operational
		100	72.9	45.8	Operational

Blank

Appendix F -
Kappler Responder/NFPA Ensemble



Figure F- 1: Kappler Responder/NFPA Ensemble - Front View



Figure F- 2: Kappler Responder/NFPA Ensemble - Side View

Table F- 1. Kappler Responder/NFPA Ensemble - Average HD Permeation

Kappler Responder/NFPA 41560													
Time (min)	Suit Material	Time (min)	Suit Seam	Time (min)	Visor Material	Time (min)	Glove	Time (min)	Suit/ Visor Interface	Time (min)	Zipper/ Material Interface	Average Time (min)	Weighted Average M_f
4	0	13	1	6	1	5	0	15	2	14	0	10	0
34	1	43	7	36	17	35	3	45	10	44	1	40	5
64	3	73	13	66	32	65	6	75	53	74	2	70	12
94	5	103	21	96	47	95	6	105	225	104	2	100	25
124	8	133	29	126	63	125	6	135	574	134	3	130	47
154	15	163	39	156	80	155	8	165	1075	164	9	160	80
184	24	193	51	186	99	185	14	195	1692	194	24	190	122
214	35	223	65	216	119	215	22	225	2400	224	54	220	170
244	48	253	80	246	139	245	33	255	3173	254	108	250	224
274	63	283	96	276	161	275	47	285	3989	284	187	280	283
304	78	313	112	306	183	305	62	315	4825	314	302	310	346
334	94	343	130	336	206	335	81	345	5668	344	458	340	412
364	111	373	148	366	229	365	102	375	6519	374	667	370	482
394	130	403	167	396	252	395	126	405	7355	404	937	400	555
424	147	433	186	426	274	425	151	435	8158	434	1292	430	630
454	164	463	205	456	298	455	180	465	8964	464	1777	460	713
484	182	493	223	486	324	485	213	495	9811	494	2420	490	806
514	199	523	243	516	352	515	249	525	10671	524	3233	520	909
544	215	553	261	546	380	545	288	555	11525	554	4206	550	1019
574	232	583	281	576	409	575	328	585	12369	584	5332	580	1138
604	249	613	299	606	439	605	370	615	13192	614	6591	610	1261
634	265	643	318	636	469	635	413	645	13997	644	7964	640	1390
664	281	673	336	666	498	665	456	675	14782	674	9451	670	1523
694	297	703	354	696	527	695	500	705	15543	704	11033	700	1659
724	312	733	371	726	554	725	543	735	16279	734	12702	730	1798
754	327	763	388	756	582	755	587	765	16980	764	14449	760	1939
784	340	793	405	786	608	785	630	795	17649	794	16239	790	2079
814	355	823	422	816	632	815	674	825	18286	824	18068	820	2221
844	369	853	440	846	656	845	717	855	18889	854	19957	850	2363
874	383	883	459	876	680	875	761	885	19466	884	21913	880	2508
904	398	913	479	906	702	905	804	915	20022	914	23915	910	2654
934	413	943	498	936	724	935	848	945	20550	944	25941	940	2799
964	429	973	518	966	746	965	892	975	21054	974	27987	970	2945
994	444	1003	538	996	767	995	935	1005	21542	1004	30048	1000	3091
1024	459	1033	557	1026	788	1025	978	1035	22006	1034	32118	1030	3235
1054	472	1063	576	1056	808	1055	1021	1065	22450	1064	34177	1060	3377
1084	486	1093	594	1086	828	1085	1062	1095	22873	1094	36207	1090	3517
1114	500	1123	612	1116	848	1115	1103	1125	23277	1124	38232	1120	3655
1144	512	1153	630	1146	866	1142	1137	1155	23665	1151	40068	1149	3781
1174	525	1183	648	1176	885	1169	1168	1185	24037	1178	41905	1178	3906
1204	537	1213	664	1206	904	1196	1197	1215	24401	1205	43750	1207	4031
1234	549	1243	681	1236	923	1223	1225	1245	24758	1232	45628	1236	4157
1264	561	1273	699	1266	941	1250	1253	1275	25099	1259	47504	1265	4282
1294	573	1303	716	1296	958	1277	1281	1305	25408	1286	49296	1294	4401
1324	585	1333	734	1326	973	1304	1307	1335	25684	1313	50992	1323	4513
1354	597	1363	751	1356	987	1331	1332	1365	25938	1340	52601	1352	4619
1384	608	1393	767	1386	1000	1358	1355	1395	26179	1367	54141	1381	4721
1414	618	1423	782	1416	1012	1385	1376	1425	26411	1394	55657	1410	4819

Note 1: The time given for each sampling area is the average of the elapsed times for the three swatches tested per sampling area.

Note 2: The avg. time is the sum of the times given for each sampling area divided by the number of sampling areas.

Note 3: Weighted average $M_f = 0.5(\text{Suit Matl } M_f) + 0.15(\text{Suit Seam } M_f) + 0.15(\text{Visor Matl } M_f) + 0.1(\text{Glove } M_f) + 0.05(\text{Suit/Visor Interface } M_f) + 0.05(\text{Zipper/Matl Interface } M_f)$.

Table F- 2. Kappler Responder/NFPA Ensemble - Average GB Permeation

Kappler Responder/NFPA 41560													
Time (min)	Suit Material	Time (min)	Suit Seam	Time (min)	Visor Material	Time (min)	Glove	Time (min)	Suit/Visor Interface	Time (min)	Zipper/Material Interface	Average Time (min)	Weighted Average M _f
5	1	14	1	5	0	5	0	14	1	14	0	10	1
35	7	44	10	35	0	35	2	44	54	44	6	40	8
65	18	74	24	65	5	65	10	74	227	74	20	70	27
95	35	104	40	95	17	95	23	104	502	104	44	100	56
125	50	134	55	125	31	125	36	134	813	134	102	130	87
155	65	164	69	155	44	155	48	164	1126	164	230	160	122
185	78	194	82	185	58	185	59	194	1429	194	467	190	161
215	90	224	95	215	71	215	71	224	1718	224	859	220	206
245	102	254	106	245	85	245	84	254	1997	254	1452	250	261
275	114	284	117	275	97	275	97	284	2273	284	2264	280	326
305	125	314	127	305	104	305	112	314	2412	314	3284	310	393
335	136	344	138	335	474	335	129	344	2560	344	4499	340	525
365	146	374	147	365	849	365	148	374	2823	374	5885	370	672
395	156	404	156	395	861	395	169	404	3053	404	7417	400	771
425	165	434	165	425	872	425	189	434	3274	434	9074	430	874
455	174	464	174	455	883	455	212	464	3486	464	10827	460	983
485	183	494	182	485	895	485	235	494	3693	494	12676	490	1095
515	191	524	190	515	905	515	259	524	3895	524	14608	520	1211
545	199	554	197	545	916	545	284	554	4088	554	16595	550	1329
575	207	584	205	575	927	575	310	584	4274	584	18597	580	1448
605	216	614	212	605	937	605	335	614	4452	614	20586	610	1566
635	223	644	220	635	948	635	361	644	4622	644	22574	640	1683
665	232	674	227	665	958	665	387	674	4785	674	24544	670	1799
695	239	704	234	695	969	695	412	704	4943	704	26497	700	1913
725	247	734	240	725	980	725	437	734	5100	734	28427	730	2027
755	255	764	247	755	990	755	462	764	5254	764	30329	760	2138
785	262	794	254	785	1001	785	487	794	5406	794	32227	790	2250
815	269	824	260	815	1012	815	512	824	5555	824	34098	820	2359
845	277	854	267	845	1023	845	536	854	5701	854	35916	850	2467
875	285	884	273	875	1034	875	559	884	5845	884	37705	880	2572
905	292	914	279	905	1045	905	583	914	5986	914	39477	910	2676
935	299	944	285	935	1056	935	606	944	6122	944	41229	940	2779
965	306	974	291	965	1067	965	629	974	6257	974	42969	970	2881
995	313	1004	297	995	1077	995	653	1004	6390	1004	44713	1000	2983
1025	320	1034	303	1025	1088	1025	677	1034	6520	1034	46442	1030	3085
1055	327	1064	309	1055	1099	1055	701	1064	6647	1064	48145	1060	3184
1085	334	1094	315	1085	1109	1085	725	1094	6772	1094	49834	1090	3283
1115	341	1124	320	1115	1119	1115	749	1124	6895	1124	51491	1120	3381
1145	347	1154	325	1145	1130	1145	772	1154	7016	1154	53122	1150	3476
1175	354	1184	331	1175	1140	1175	795	1184	7136	1184	54739	1180	3571
1205	361	1214	337	1205	1150	1205	818	1214	7255	1214	56349	1210	3665
1235	367	1244	342	1235	1161	1235	841	1244	7370	1244	57945	1240	3759
1265	374	1274	347	1265	1170	1265	863	1274	7484	1274	59520	1270	3851
1295	381	1304	353	1295	1181	1295	885	1304	7597	1304	61071	1300	3942
1325	387	1334	358	1325	1190	1325	906	1334	7708	1334	62576	1330	4031
1355	395	1364	364	1355	1200	1355	926	1364	7817	1364	64019	1360	4116
1385	401	1394	370	1385	1209	1385	946	1394	7923	1394	65416	1390	4199
1415	408	1424	375	1415	1219	1415	965	1424	8028	1424	66791	1420	4281

Note 1: The time given for each sampling area is the average of the elapsed times for the three swatches tested per sampling area.

Note 2: The avg. time is the sum of the times given for each sampling area divided by the number of sampling areas.

Note 3: Weighted average M_f = 0.5(Suit Matl M_f) + 0.15(Suit Seam M_f) + 0.15(Visor Matl M_f) + 0.1(Glove M_f) + 0.05(Suit/Visor Interface M_f) + 0.05(Zipper/Matl Interface M_f).

Kappler Responder/NFPA 41560

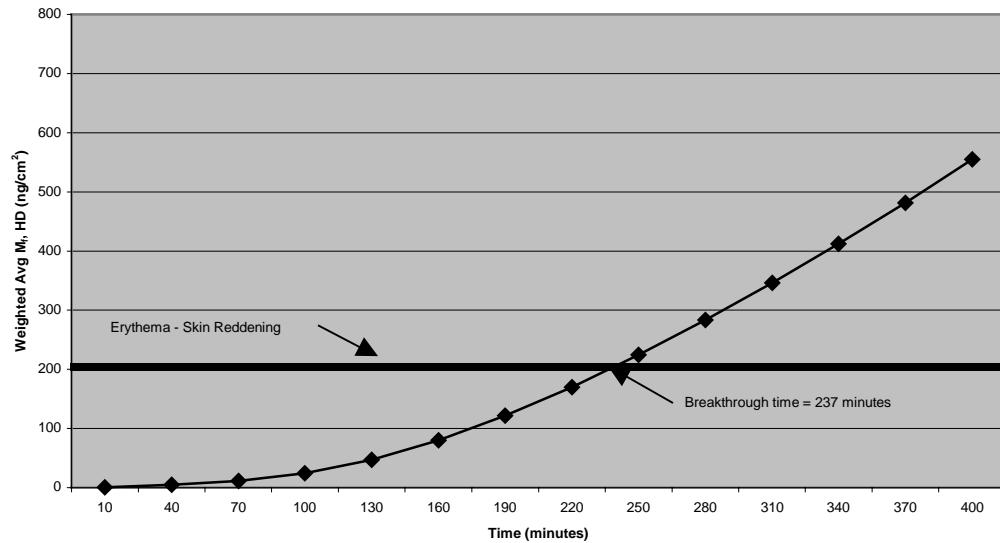


Figure F- 3: Kappler Responder/NFPA Ensemble - Weighted Average HD Permeation

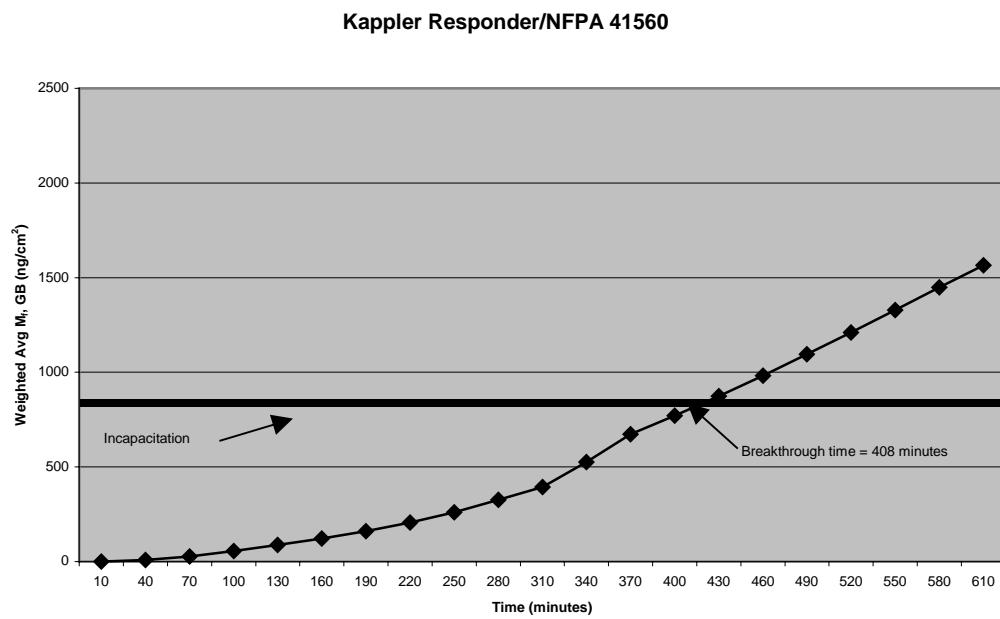


Figure F- 4: Kappler Responder/NFPA Ensemble - Weighted Average GB Permeation

Kappler Responder/NFPA 41560

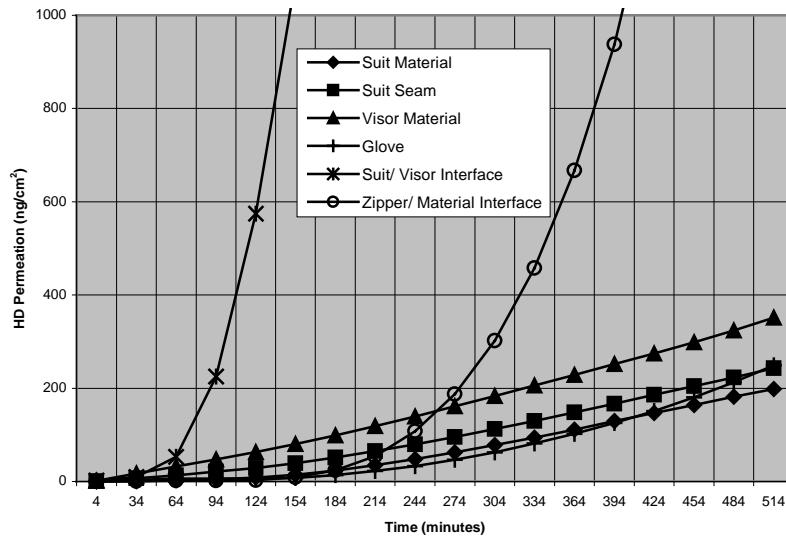


Figure F- 5: Kappler Responder/NFPA Ensemble: HD Permeation By Sampling Area

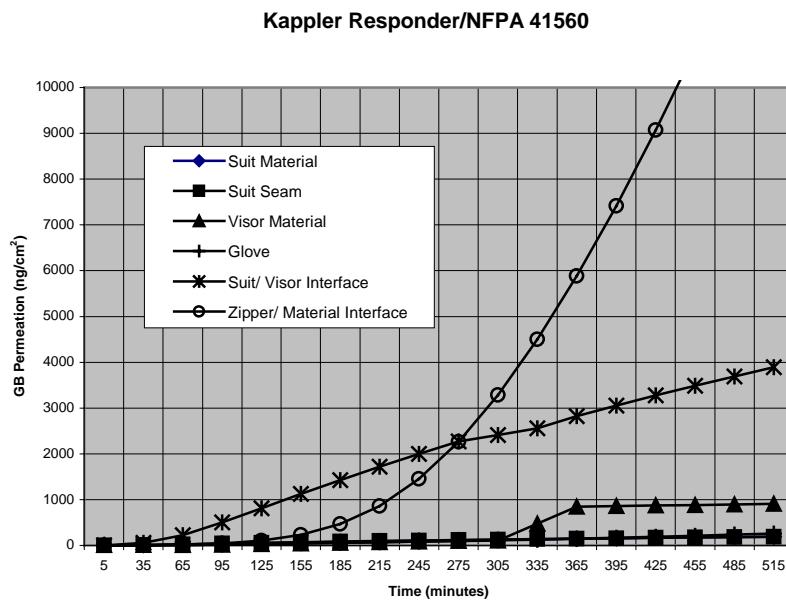


Figure F- 6: Kappler Responder/NFPA Ensemble: GB Permeation By Sampling Area

Table F- 3. Kappler Responder/NFPA Ensemble - System Test (Aerosol Simulant) Results

PF	Visor Region and Upper Arm, Combined					
	Pre-Operational Exercises			Operational Exercises		
	No. of Occasions	Cumulative Rate, Percent	Cumulative Pass Rate, Percent	No. of Occasions	Cumulative Rate, Percent	Cumulative Pass Rate, Percent
0	0	0	100	0	0	100
10	0	0	100	0	0	100
50	0	0	100	0	0	100
100	0	0	100	0	0	100
150	0	0	100	0	0	100
500	7	13.0	87.0	6	12.0	88.0
1000	8	27.8	72.2	10	32.0	68.0
1667	12	50.0	50.0	4	40.0	60.0
2000	1	51.9	48.1	4	48.0	52.0
5000	23	94.4	5.6	15	78.0	22.0
6667	2	98.2	1.8	1	80.0	20.0
10000	1	100	0	4	88.0	12.0
20000	0	100	0	5	98.0	2.0
50000	0	100	0	1	100	0
100000	0	100	0	0	100	0
No. of Trials	54			50		

Table F- 4. Kappler Responder/NFPA Ensemble - Overall Test Results

Breakthrough Time (minutes)		Aerosol PF Pass Rate at PF Equal to:			Exercise Phase
Incapacitation	Erythema	100	1000	2000	
GB	HD				
408	237	100	72.2	48.1	Pre-Operational
		100	68.0	52.0	Operational

Blank

Appendix G -
Trelleborg Trellchem VPS



Figure G- 1: Trellchem VPS - Front View



Figure G- 2: Trellchem VPS - Side View

Table G- 1. Trelleborg Trellchem VPS - Average HD Permeation

Trelleborg Trellchem VPS Suit													
Time (min)	Suit Material	Time (min)	Suit Seam	Time (min)	Visor Material	Time (min)	Boot Material	Time (min)	Suit/Visor Interface	Time (min)	Zipper/Material Interface	Average Time (min)	Weighted Average Mf
4	0	13	0	13	4	14	5	4	1	5	3	9	1
34	0	43	2	43	20	44	21	34	16	35	35	39	8
64	2	73	4	73	33	74	34	64	31	65	61	69	14
94	6	103	5	103	46	104	46	94	47	95	91	99	22
124	14	133	10	133	60	134	63	124	67	125	144	129	35
154	27	163	18	163	78	164	92	154	92	155	253	159	54
184	45	193	28	193	98	194	138	184	122	185	460	189	84
214	69	223	41	223	121	224	202	214	157	215	798	219	127
244	98	253	56	253	146	254	286	244	196	245	1285	249	182
274	133	283	74	283	173	284	387	274	239	275	1922	279	251
304	174	313	96	313	201	314	500	304	285	305	2673	309	329
334	217	343	119	343	231	344	620	334	332	335	3507	339	415
364	263	373	143	373	262	374	742	364	382	365	4408	369	506
394	310	403	168	403	293	404	866	394	433	395	5350	399	600
424	357	433	194	433	325	434	991	424	485	425	6321	429	696
454	405	463	221	463	357	464	1116	454	537	455	7316	459	794
484	453	493	247	493	390	494	1242	484	589	485	8309	489	891
514	499	523	273	523	422	524	1365	514	642	515	9293	519	987
544	545	553	299	553	454	554	1486	544	694	545	10285	549	1083
574	590	583	324	583	486	584	1606	574	745	575	11287	579	1178
604	632	613	348	613	517	614	1724	604	796	605	12297	609	1273
634	672	643	371	643	548	644	1842	634	845	635	13302	639	1365
664	711	673	394	673	577	674	1959	664	893	665	14295	669	1457
694	749	703	416	704	608	704	2077	695	940	695	15288	699	1547
724	786	733	436	734	640	734	2195	725	988	725	16280	729	1637
754	822	763	457	764	670	764	2311	755	1036	755	17259	759	1726
784	855	793	477	794	699	794	2425	785	1082	785	18234	789	1812
814	888	823	496	824	728	824	2535	815	1125	815	19196	819	1897
844	918	853	514	854	756	854	2644	845	1167	845	20132	849	1979
874	947	883	531	885	783	884	2752	876	1208	875	21048	879	2058
904	975	913	547	915	809	914	2857	906	1248	905	21951	909	2136
934	1001	943	562	945	833	944	2960	936	1287	935	22849	940	2212
964	1025	973	578	975	857	974	3061	966	1325	965	23743	970	2287
994	1049	1003	592	1005	880	1004	3160	996	1362	995	24612	1000	2360
1024	1072	1033	605	1035	904	1034	3256	1026	1399	1025	25458	1030	2431
1054	1093	1063	618	1066	928	1064	3349	1057	1436	1055	26283	1060	2500
1084	1114	1093	631	1096	952	1094	3442	1087	1473	1085	27079	1090	2566
1114	1134	1123	643	1126	976	1124	3533	1117	1510	1115	27856	1120	2631
1144	1152	1153	655	1156	999	1154	3623	1147	1546	1145	28620	1150	2695
1174	1170	1183	666	1186	1023	1184	3716	1177	1582	1175	29363	1180	2757
1204	1187	1213	677	1216	1046	1214	3809	1207	1618	1205	30080	1210	2818
1234	1204	1243	688	1247	1070	1244	3902	1238	1654	1235	30772	1240	2877
1264	1219	1273	699	1277	1092	1274	3994	1268	1689	1265	31440	1270	2934
1294	1234	1303	709	1307	1114	1304	4081	1298	1723	1295	32099	1300	2990
1324	1248	1333	718	1337	1135	1334	4160	1328	1754	1325	32731	1330	3042
1354	1262	1363	728	1367	1155	1364	4235	1358	1784	1355	33326	1360	3092
1384	1276	1393	738	1397	1175	1394	4307	1388	1814	1385	33896	1390	3141
1414	1290	1423	747	1428	1195	1424	4376	1419	1845	1415	34441	1420	3188

Note 1: The time given for each sampling area is the average of the elapsed times for the three swatches tested per sampling area.

Note 2: The avg. time is the sum of the times given for each sampling area divided by the number of sampling areas.

Note 3: Weighted average Mf = 0.5(Suit Matl Mf) + 0.15(Suit Seam Mf) + 0.15(Visor Matl Mf) + 0.1(Boot Material Mf) + 0.05(Suit/Visor Interface Mf) + 0.05(Zipper/Matl Interface Mf).

Table G- 2. Trelleborg Trellchem VPS – Average GB Permeation

Trelleborg Trellchem VPS Suit													
Time (min)	Suit Material	Time (min)	Suit Seam	Time (min)	Visor Material	Time (min)	Boot Material	Time (min)	Suit/ Visor Interface	Time (min)	Zipper/ Material Interface	Average Time (min)	Weighted Average Mf
6	0	15	0	14	0	5	0	4	0	14	1	10	0
36	5	45	22	44	18	35	14	35	149	44	16	40	18
66	12	75	66	74	47	66	39	65	334	75	41	70	45
96	17	105	101	104	70	96	64	95	396	105	64	100	64
126	22	135	123	134	90	126	87	125	442	135	85	130	78
156	26	165	138	164	108	156	108	155	478	165	104	160	90
186	29	195	149	195	124	186	126	186	510	195	122	190	100
216	32	225	159	225	139	216	141	216	538	225	139	220	109
246	35	255	167	255	153	247	156	246	564	256	155	251	117
276	38	285	175	285	165	277	169	276	588	286	172	281	125
306	41	315	182	315	177	307	181	306	610	316	188	311	133
336	44	345	189	345	188	337	192	336	632	346	203	341	140
366	47	375	195	376	199	367	203	367	653	376	219	371	146
396	50	405	201	406	208	397	212	397	673	406	234	401	153
426	53	435	207	436	217	428	222	427	691	437	249	431	159
456	55	465	212	466	226	458	231	457	710	467	263	461	165
486	58	495	216	496	234	488	239	487	728	497	277	491	171
516	61	525	220	526	242	518	246	517	745	527	291	522	176
546	63	555	224	557	250	548	254	548	762	557	304	552	181
576	66	585	228	587	258	578	260	578	779	587	316	582	187
606	68	615	232	617	265	609	266	608	795	618	327	612	192
636	71	645	236	647	272	639	272	638	811	648	338	642	196
666	73	675	240	677	278	669	277	668	827	678	349	672	201
696	76	705	243	707	285	699	283	698	842	708	359	702	205
726	78	735	247	738	291	729	288	729	857	738	368	732	210
756	81	765	250	768	297	759	292	759	872	768	377	762	214
786	83	795	253	798	303	790	297	789	887	799	385	793	218
816	85	825	256	828	309	820	301	819	901	829	393	823	222
846	87	855	259	858	314	850	305	849	916	859	401	853	226
876	90	885	262	888	319	880	309	879	929	889	408	883	230
906	91	915	265	919	325	910	313	910	943	919	415	913	233
936	93	945	267	949	330	940	316	940	956	949	421	943	236
966	94	975	270	979	335	971	320	970	970	980	428	973	240
996	96	1005	273	1009	339	1001	323	1000	983	1010	433	1004	243
1027	98	1036	275	1039	344	1031	326	1030	995	1040	439	1034	246
1057	100	1066	278	1069	349	1061	330	1060	1007	1070	444	1064	250
1087	102	1096	281	1100	353	1091	333	1091	1020	1100	450	1094	253
1117	104	1126	283	1130	357	1121	336	1121	1031	1130	454	1124	256
1147	106	1156	285	1160	361	1152	339	1151	1043	1161	460	1154	259
1177	109	1186	288	1190	365	1182	342	1181	1055	1191	465	1185	262
1208	111	1217	290	1220	369	1212	347	1211	1066	1221	471	1215	266
1238	113	1247	292	1250	373	1242	351	1241	1077	1251	476	1245	269
1268	116	1277	295	1281	377	1272	355	1272	1088	1281	482	1275	273
1298	118	1307	297	1311	381	1302	360	1302	1100	1311	487	1305	276
1328	121	1337	299	1341	385	1333	364	1332	1111	1342	492	1335	280
1358	123	1367	301	1371	389	1363	368	1362	1122	1372	497	1366	283
1389	126	1398	303	1401	393	1393	372	1392	1133	1402	501	1396	286
1419	129	1428	306	1431	397	1423	375	1422	1144	1432	505	1426	290

Note 1: The time given for each sampling area is the average of the elapsed times for the three swatches tested per sampling area.

Note 2: The avg. time is the sum of the times given for each sampling area divided by the number of sampling areas.

Note 3: Weighted average Mf = 0.5(Suit Matl Mf) + 0.15(Suit Seam Mf) + 0.15(Visor Matl Mf) + 0.1(Boot Material Mf) + 0.05(Suit/Visor Interface Mf) + 0.05(Zipper/Matl Interface Mf).

Trelleborg VPS Suit

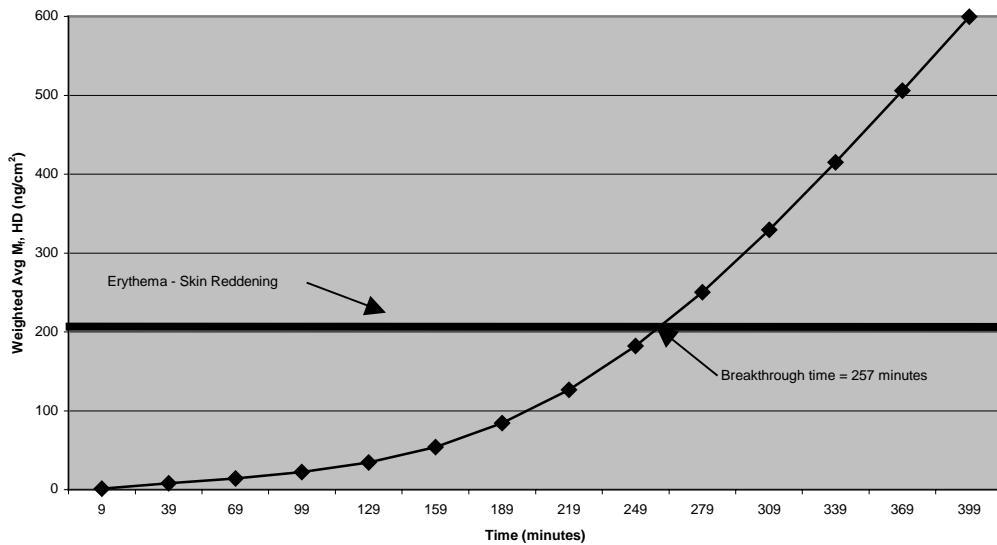


Figure G- 3: Trelleborg Trellchem VPS- Weighted Average HD Permeation

Trelleborg VPS Suit

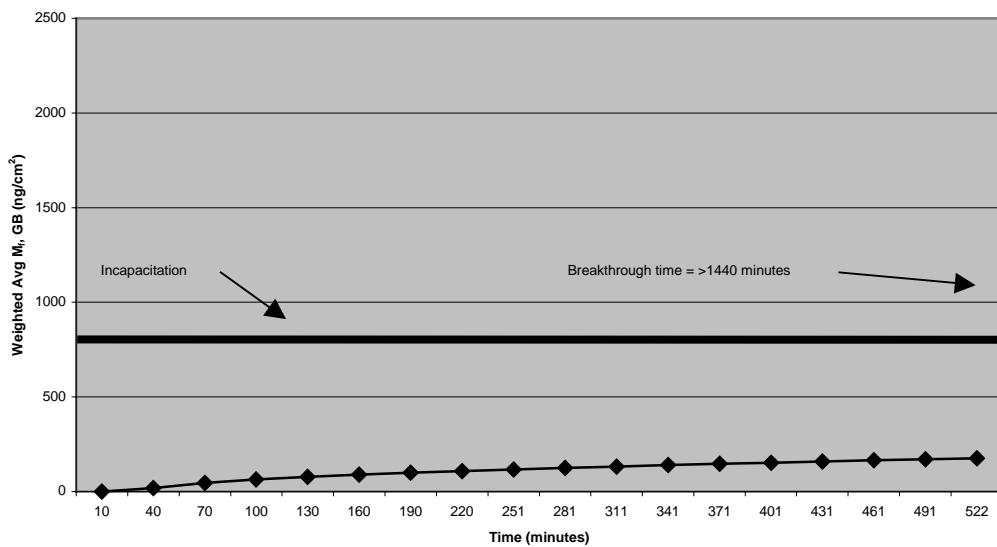


Figure G- 4: Trelleborg Trellchem VPS - Weighted Average GB Permeation

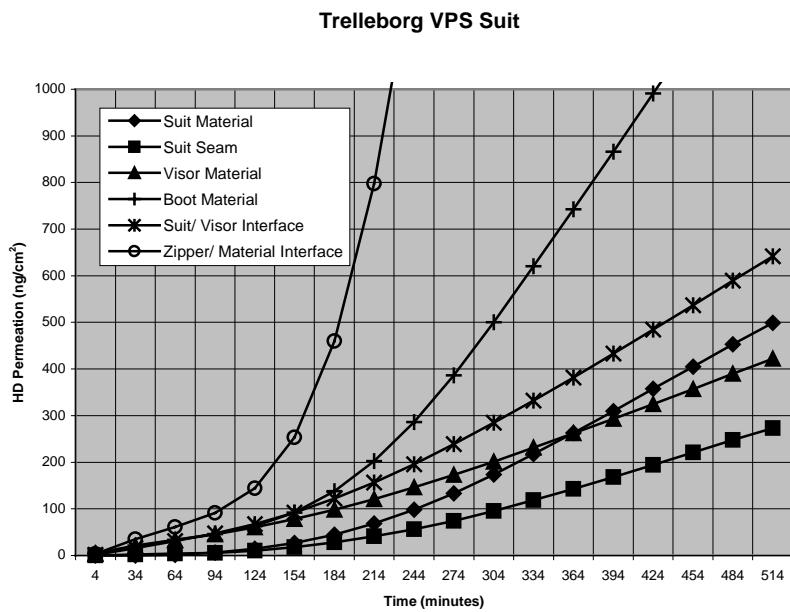


Figure G- 5: Trelleborg Trellchem VPS - HD Permeation by Sampling Area

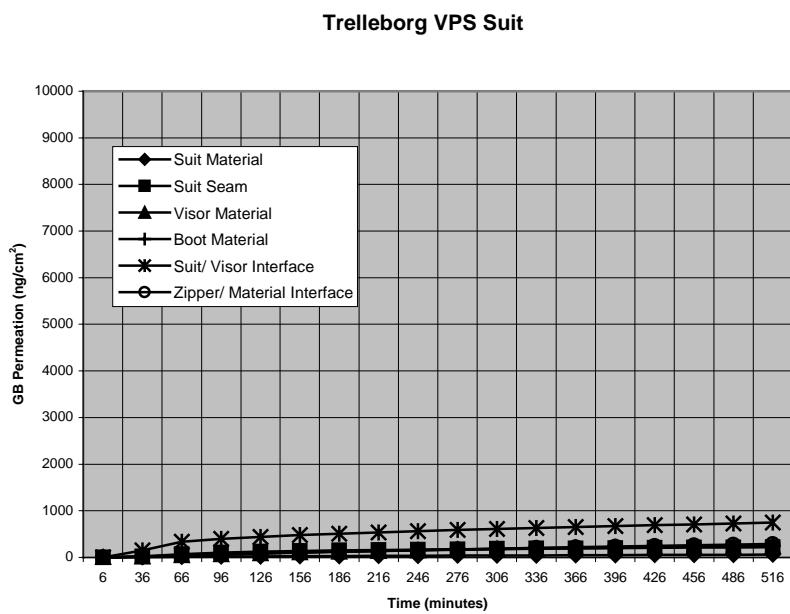


Figure G- 6: Trelleborg Trellchem VPS - GB Permeation by Sampling Area

Table G- 3. Trelleborg Trellchem VPS - System Test (Aerosol Simulant) Results

PF	Visor Region and Upper Arm, Combined					
	Pre-Operational Exercises			Operational Exercises		
	No. of Occasions	Cumulative Rate, Percent	Cumulative Pass Rate, Percent	No. of Occasions	Cumulative Rate, Percent	Cumulative Pass Rate, Percent
0	0	0	100	0	0	100
10	0	0	100	0	0	100
50	0	0	100	0	0	100
100	0	0	100	0	0	100
150	0	0	100	0	0	100
500	0	0	100	1	2.3	97.7
1000	0	0	100	1	4.6	95.4
1667	3	6.3	93.7	0	4.6	95.4
2000	1	8.3	91.7	0	4.6	95.4
5000	23	56.3	43.7	5	15.9	84.1
6667	7	70.8	29.2	6	29.6	70.4
10000	7	85.4	14.6	11	54.6	45.4
20000	4	93.8	6.2	10	77.3	22.7
50000	1	95.8	4.2	10	100	0
100000	2	100	0	0	100	0
No. of Trials	48			44		

Table G- 4. Trelleborg Trellchem VPS - Overall Test Results

Breakthrough Time (minutes)		Aerosol PF Pass Rate at PF Equal to:			Exercise Phase
Incapacitation	Erythema	100	1000	2000	
GB	HD				
>1440	257	100	100	91.7	Pre-Operational
		100	95.4	95.4	Operational

Blank

Appendix H -
Trelleborg Trellchem TSE



Figure H- 1: Trellchem TSE - Front View



Figure H- 2: Trellchem TSE - Side View

Table H- 1. Trelleborg Trellchem TSE - Average HD Permeation

Trelleborg Trellchem TSE Suit													
Time (min)	Suit Material	Time (min)	Suit Seam	Time (min)	Visor Material	Time (min)	Boot Seam	Time (min)	Suit/ Visor Interface	Time (min)	Zipper/ Material Interface	Average Time (min)	Weighted Average Mf
5	0	14	0	5	0	4	6	14	0	13	6	9	1
35	0	44	2	35	0	34	84	44	0	43	37	39	11
65	0	74	4	65	0	64	178	74	0	73	76	69	22
95	0	104	6	95	0	94	282	104	0	103	121	99	35
125	2	134	7	125	1	124	396	134	0	133	181	129	51
155	7	164	10	155	5	154	517	164	2	163	274	159	71
185	16	194	15	185	13	184	645	194	6	193	444	189	99
215	27	224	21	215	22	214	779	224	11	223	795	219	138
245	41	254	28	245	34	244	919	254	19	253	1503	249	198
275	56	284	37	275	48	274	1065	284	28	283	2748	279	286
305	74	314	45	305	64	304	1215	314	38	313	4623	309	408
335	92	344	54	335	82	334	1368	344	48	343	7038	339	558
365	111	374	64	365	101	364	1524	374	59	373	9837	369	727
395	129	404	73	395	120	394	1683	404	71	403	12864	399	909
425	148	434	83	425	140	424	1844	434	84	433	16000	429	1096
455	166	464	93	455	160	454	2008	464	96	463	19210	459	1287
485	185	494	102	485	180	484	2175	494	110	493	22454	489	1481
515	203	524	112	515	201	514	2343	524	124	523	25721	519	1675
545	221	554	121	545	221	544	2513	554	139	553	29026	549	1871
575	238	584	130	575	241	574	2684	584	153	583	32348	579	2068
605	255	614	139	605	261	604	2856	614	169	613	35669	609	2265
635	271	644	148	635	282	634	3027	644	185	643	38994	639	2462
665	287	674	157	665	302	664	3199	674	201	673	42338	669	2659
695	303	704	165	695	322	694	3372	704	218	703	45703	699	2858
725	317	734	174	725	343	724	3545	734	235	733	49077	729	3056
755	332	764	182	755	363	754	3716	764	252	763	52452	759	3255
785	346	794	190	785	381	784	3887	794	269	793	55837	789	3453
815	360	824	198	815	400	814	4060	824	286	823	59233	819	3652
845	374	854	207	845	417	844	4234	854	303	853	62623	849	3850
875	387	884	215	875	435	874	4406	884	321	883	66007	879	4048
905	400	914	222	905	452	904	4576	914	338	913	69382	909	4245
935	414	944	231	935	468	934	4744	944	356	943	72748	939	4441
965	426	974	238	965	484	964	4911	974	374	973	76113	969	4637
995	439	1004	246	995	500	994	5076	1004	393	1003	79470	999	4832
1025	451	1034	253	1025	515	1024	5241	1034	411	1033	82826	1029	5027
1055	463	1064	261	1052	524	1054	5404	1061	426	1063	86177	1058	5220
1085	474	1094	268	1079	526	1081	5551	1088	437	1090	89185	1086	5392
1112	479	1121	271	1106	526	1108	5698	1115	447	1117	92191	1113	5561
1139	480	1148	272	1133	526	1135	5844	1142	456	1144	95204	1140	5727
1166	480	1175	272	1160	526	1162	5991	1169	466	1171	98215	1167	5893
1193	480	1202	273	1187	526	1189	6136	1196	476	1199	69834	1194	4489
1220	480	1229	273	1214	526	1213	6260	1223	486	1226	71863	1221	4603
1247	480	1256	273	1241	526	1234	6360	1250	496				
1274	480	1283	273	1268	526	1255	6454	1277	507				
1301	480	1310	273	1295	526	1273	6530	1304	518				
1328	480	1337	273	1322	526	1291	6613	1331	529				
1355	480	1364	273	1349	526	1309	6731	1358	540				
1382	480	1391	274	1376	526	1327	6943	1385	551				

Note 1: The time given for each sampling area is the average of the elapsed times for the three swatches tested per sampling area.

Note 2: The avg. time is the sum of the times given for each sampling area divided by the number of sampling areas.

Note 3: Weighted average Mf = 0.5(Suit Matl Mf) + 0.15(Suit Seam Mf) + 0.15(Visor Matl Mf) + 0.1(Boot Seam Mf) + 0.05(Suit/Visor Interface Mf) + 0.05(Zipper/Matl Interface Mf).

Table H- 2. Trelleborg Trellchem TSE - Average GB Permeation

Trelleborg Trellchem TSE Suit													
Time (min)	Suit Material	Time (min)	Suit Seam	Time (min)	Visor Material	Time (min)	Boot Seam	Time (min)	Suit/ Visor Interface	Time (min)	Zipper/ Material Interface	Average Time (min)	Weighted Average M_f
4	0	13	6	4	2	4	3	13	9	13	25	9	3
34	5	43	38	34	19	34	34	43	155	43	180	39	31
64	10	73	113	64	34	64	52	73	461	73	504	69	81
94	14	103	265	94	50	94	70	103	800	103	1036	99	153
124	19	133	479	124	67	124	89	133	1090	133	1694	129	239
154	26	163	729	154	82	154	110	163	1331	163	2421	159	333
184	36	193	999	184	97	184	132	193	1532	193	3189	189	432
214	48	223	1281	214	113	214	153	223	1699	223	3973	219	532
244	60	253	1569	244	128	244	175	253	1840	253	4756	249	632
274	73	283	1859	274	144	274	197	283	1962	283	5534	279	731
304	87	313	2146	304	159	304	217	313	2070	313	6304	309	830
334	101	343	2427	334	174	334	239	343	2166	343	7072	339	926
364	115	373	2708	364	189	364	261	373	2251	373	7828	369	1022
394	130	403	2987	394	205	394	283	403	2329	403	8566	399	1117
424	145	433	3265	424	220	424	305	433	2402	433	9290	429	1210
454	160	463	3542	454	235	454	327	463	2470	463	10008	459	1303
484	175	493	3814	484	250	484	348	493	2533	493	10715	489	1395
514	190	523	4081	514	266	514	370	523	2592	523	11402	519	1484
544	205	553	4345	544	281	544	391	553	2646	553	12075	549	1572
574	221	583	4604	574	296	574	412	583	2699	583	12739	579	1658
604	236	613	4857	604	310	604	432	613	2749	613	13390	609	1743
634	252	643	5104	634	325	634	453	643	2796	643	14034	639	1827
664	267	673	5349	664	339	664	474	673	2840	673	14663	669	1909
694	282	703	5593	694	354	694	495	703	2883	703	15283	699	1991
724	298	733	5832	724	368	724	516	733	2924	733	15899	729	2072
754	314	763	6068	754	382	754	537	763	2964	763	16511	759	2152
784	329	793	6306	784	396	784	558	793	3002	793	17119	789	2232
814	345	823	6542	814	410	814	580	823	3038	823	17715	819	2311
844	360	853	6772	844	425	844	602	853	3073	853	18304	849	2389
874	376	883	6997	874	439	874	623	883	3107	883	18887	879	2465
904	391	913	7219	904	452	904	643	913	3140	913	19459	909	2541
934	407	943	7439	934	466	934	664	943	3171	943	20026	939	2616
964	423	973	7657	964	480	964	685	973	3201	973	20584	969	2690
994	438	1003	7871	994	493	994	705	1003	3231	1003	21133	999	2762
1024	453	1033	8079	1024	507	1024	726	1033	3260	1033	21679	1029	2834
1054	469	1063	8283	1054	520	1054	746	1063	3288	1063	22221	1059	2905
1084	484	1093	8485	1084	533	1084	767	1093	3315	1093	22760	1089	2975
1114	500	1123	8684	1114	546	1114	788	1123	3342	1123	23293	1119	3045
1144	516	1153	8879	1144	560	1144	809	1153	3368	1153	23820	1149	3114
1174	531	1183	9069	1174	573	1174	830	1183	3394	1183	24341	1179	3182
1204	547	1213	9255	1204	586	1204	850	1213	3419	1213	24854	1209	3248
1234	562	1243	9442	1234	599	1234	870	1243	3445	1243	25359	1239	3314
1264	577	1273	9627	1264	612	1264	890	1273	3469	1273	25860	1269	3380
1294	593	1303	9808	1294	625	1294	911	1303	3493	1303	26355	1299	3445
1324	608	1333	9991	1324	638	1324	934	1333	3517	1333	26842	1329	3510
1354	623	1363	10172	1354	651	1354	956	1363	3540	1363	27327	1359	3574
1384	639	1393	10351	1384	664	1384	979	1393	3562	1393	27813	1389	3638
1414	654	1423	10531	1414	677	1414	1000	1423	3585	1423	28296	1419	3702

Note 1: The time given for each sampling area is the average of the elapsed times for the three swatches tested per sampling area.

Note 2: The avg. time is the sum of the times given for each sampling area divided by the number of sampling areas.

Note 3: Weighted average $M_f = 0.5(\text{Suit Matl } M_f) + 0.15(\text{Suit Seam } M_f) + 0.15(\text{Visor Matl } M_f) + 0.1(\text{Boot Seam } M_f) + 0.05(\text{Suit/Visor Interface } M_f) + 0.05(\text{Zipper/Matl Interface } M_f)$.

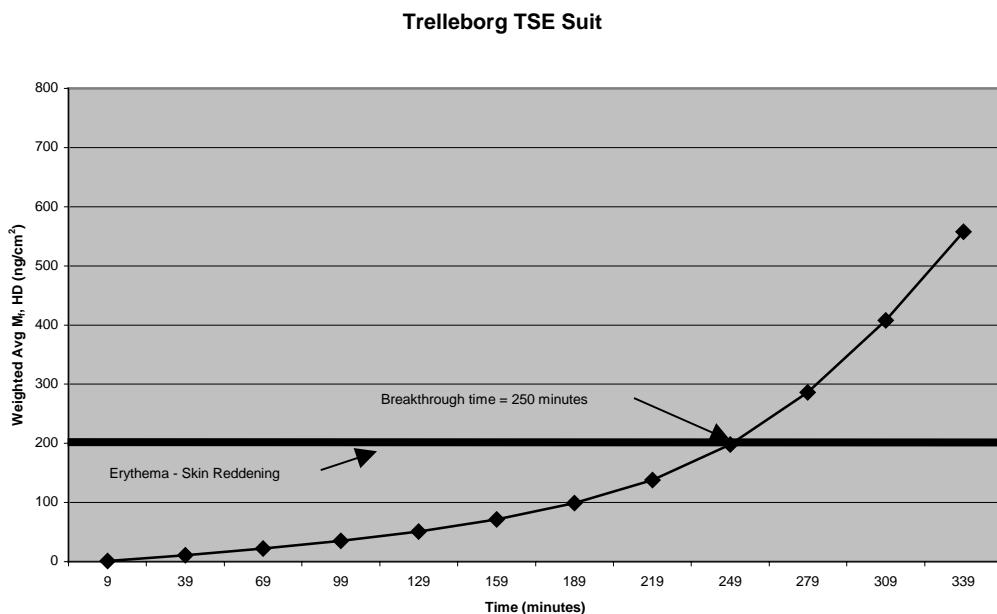


Figure H- 3: Trelleborg Trellchem TSE - Weighted Average HD Permeation

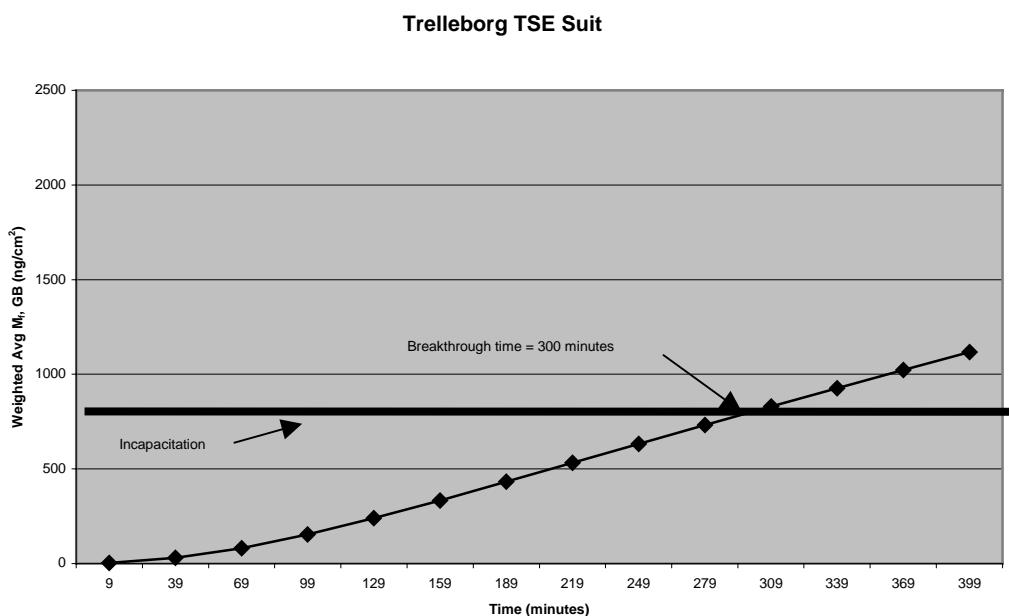


Figure H- 4: Trelleborg Trellchem TSE - Weighted Average GB Permeation

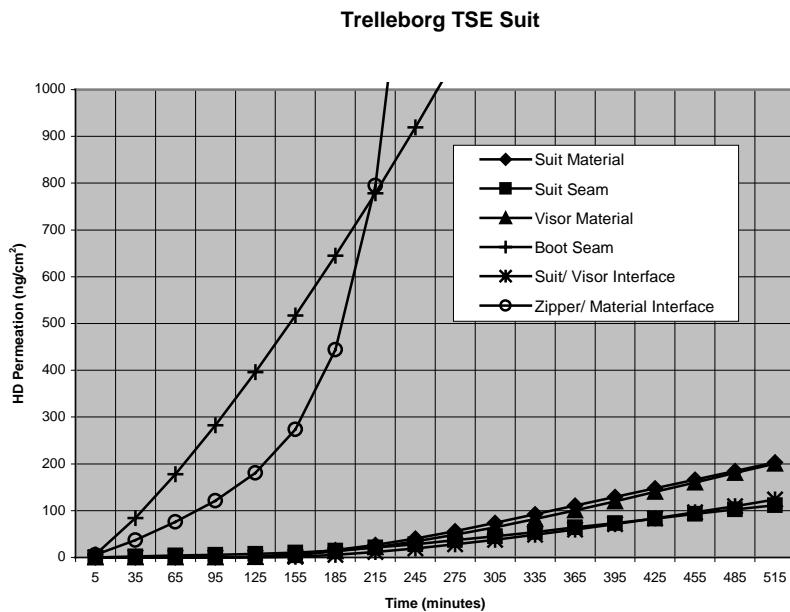


Figure H- 5: Trelleborg Trellchem TSE: HD Permeation by Sampling Area

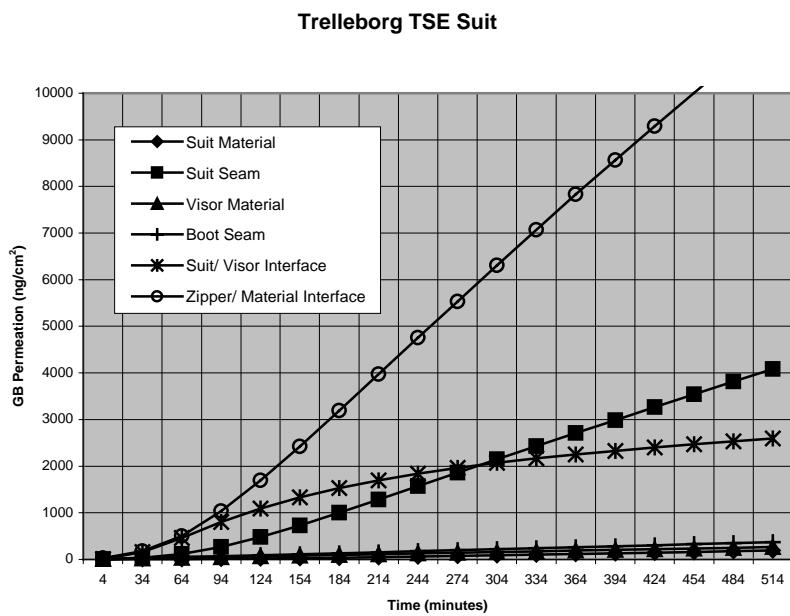


Figure H- 6: Trelleborg Trellchem TSE: GB Permeation by Sampling Area

Table H- 3. Trelleborg Trellchem TSE - System Test (Aerosol Simulant) Results

PF	Visor Region and Upper Arm, Combined					
	Pre-Operational Exercises			Operational Exercises		
	No. of Occasions	Cumulative Rate, Percent	Cumulative Pass Rate, Percent	No. of Occasions	Cumulative Rate, Percent	Cumulative Pass Rate, Percent
0	0	0	100	0	0	100
10	0	0	100	0	0	100
50	0	0	100	0	0	100
100	0	0	100	0	0	100
150	0	0	100	0	0	100
500	0	0	100	1	2.1	97.9
1000	0	0	100	0	2.1	97.9
1667	0	0	100	0	2.1	97.9
2000	2	4.2	95.8	0	2.1	97.9
5000	21	47.9	52.1	1	4.2	95.8
6667	10	68.8	32.2	1	6.3	93.7
10000	8	85.4	14.6	4	14.6	85.4
20000	7	100	0	19	54.2	45.8
50000-99999	0	100	0	11	77.1	22.9
100000+	0	100	0	11	100	0
No. of Trials	48			48		

Table H- 4. Trelleborg Trellchem TSE - Overall Test Results

Breakthrough Time (minutes)		Aerosol PF Pass Rate at PF Equal to:			Exercise Phase
Incapacitation	Erythema	100	1000	2000	
GB	HD				
300	250	100	100	95.8	Pre-Operational
		100	97.9	97.9	Operational

Blank

Appendix I -
Trelleborg Trellchem TBE



Figure I- 1: Trellchem TBE – Front View



Figure I- 2: Trellchem TBE - Side View

Table I- 1. Trelleborg Trellchem TBE - Average HD Permeation

Trelleborg Trellchem TBE Suit													
Time (min)	Suit Material	Time (min)	Suit Seam	Time (min)	Visor Material	Time (min)	Boot Seam	Time (min)	Suit/ Visor Interface	Time (min)	Zipper/ Material Interface	Average Time (min)	Weighted Average Mf
4	4	13	41	5	6	5	3	14	13	14	5	9	10
34	59	43	249	35	97	35	36	44	88	44	29	39	91
64	111	73	440	65	199	65	72	74	177	74	53	69	170
94	161	103	617	95	294	95	109	104	262	104	78	99	245
124	211	133	779	125	387	125	151	134	347	134	112	129	319
154	264	163	930	155	480	155	198	164	433	164	167	159	393
184	320	193	1074	185	574	185	251	194	520	194	267	189	471
214	377	223	1212	215	668	215	308	224	608	224	465	219	555
244	436	253	1344	245	764	245	369	254	696	254	857	249	649
274	497	283	1474	275	861	275	434	284	786	284	1529	279	758
304	560	313	1601	305	959	305	501	314	875	314	2553	309	885
334	624	343	1727	335	1057	335	570	344	965	344	3946	339	1032
364	691	373	1848	365	1156	365	642	374	1056	374	5683	369	1197
394	761	403	1969	395	1254	395	716	404	1147	404	7683	399	1377
424	836	433	2085	425	1352	425	793	434	1239	434	9849	429	1567
454	917	463	2199	455	1450	455	873	464	1329	464	12104	459	1765
484	1007	493	2313	485	1547	485	954	494	1419	494	14398	489	1969
514	1108	523	2426	515	1644	515	1038	524	1508	524	16739	519	2181
544	1226	553	2540	545	1740	545	1123	554	1597	554	19108	549	2403
574	1367	583	2653	575	1836	575	1211	584	1685	584	21496	579	2637
604	1540	613	2768	605	1931	605	1301	614	1774	614	23909	609	2889
634	1755	643	2886	635	2026	635	1394	644	1862	644	26334	639	3163
664	2023	673	3007	665	2120	665	1487	674	1949	674	28757	669	3465
694	2358	703	3133	695	2214	695	1585	704	2037	704	31174	699	3800
724	2771	733	3263	725	2308	725	1685	734	2125	734	33586	729	4175
754	3272	763	3398	755	2402	755	1788	764	2212	764	35990	759	4595
784	3872	793	3538	785	2495	785	1895	794	2299	794	38395	789	5065
814	4580	823	3686	815	2589	815	2008	824	2385	824	40798	819	5591
844	5402	853	3843	845	2682	845	2125	854	2471	854	43184	849	6175
874	6339	883	4009	875	2774	875	2248	884	2557	884	45558	879	6817
904	7399	913	4184	905	2865	905	2378	914	2643	914	47924	909	7523
934	8588	943	4370	935	2957	935	2515	944	2728	944	50275	939	8295
964	9904	973	4567	965	3047	965	2659	974	2812	974	52608	969	9131
994	11328	1003	4777	995	3137	995	2810	1004	2897	1004	54935	999	10024
1024	12869	1033	4999	1025	3228	1025	2973	1034	2982	1034	57254	1029	10978
1054	14523	1063	5231	1055	3317	1055	3146	1064	3065	1064	59561	1059	11990
1084	16269	1093	5477	1085	3407	1082	3308	1094	3149	1091	61630	1088	13037
1114	18106	1123	5734	1115	3496	1109	3476	1124	3233	1118	63693	1117	14131
1144	20027	1153	6003	1145	3585	1136	3653	1154	3316	1145	65748	1146	15270
1171	21819	1180	6252	1175	3674	1163	3840	1184	3400	1172	67795	1174	16342
1198	23667	1207	6509	1205	3762	1190	4037	1214	3482	1199	69834	1202	17444
1225	25577	1234	6777	1235	3850	1217	4247	1244	3565	1226	71863	1230	18579
1252	27537	1261	7053	1262	3926	1244	4470	1271	3638				
1279	29533	1288	7338	1289	3962	1268	4676	1298	3674				
1306	31577	1315	7635	1316	3962	1292	4886	1325	3674				
1333	33675	1342	7945	1343	3962	1313	5074	1352	3674				
1360	35812	1369	8268			1334	5265						
1387	37978	1396	8601			1355	5462						

Note 1: The time given for each sampling area is the average of the elapsed times for the three swatches tested per sampling area.

Note 2: The avg. time is the sum of the times given for each sampling area divided by the number of sampling areas.

Note 3: Weighted average Mf = 0.5(Suit Matl Mf) + 0.15(Suit Seam Mf) + 0.15(Visor Matl Mf) + 0.1(Boot Seam Mf) + 0.05(Suit/Visor Interface Mf) + 0.05(Zipper/Matl Interface Mf).

Table I- 2. Trelleborg Trellchem TBE - Average GB Permeation

Trelleborg Trellchem TBE Suit													
Time (min)	Suit Material	Time (min)	Suit Seam	Time (min)	Visor Material	Time (min)	Boot Seam	Time (min)	Suit/ Visor Interface	Time (min)	Zipper/ Material Interface	Average Time (min)	Weighted Average Mf
5	0	14	0	4	7	5	0	13	8	14	0	9	1
35	5	44	1428	34	92	35	12	43	546	44	20	39	260
65	44	74	4349	64	206	65	30	73	1454	74	57	69	784
95	120	104	7326	94	373	95	43	103	2152	104	96	99	1332
125	207	134	10268	124	542	125	55	133	2770	134	140	129	1876
155	295	164	13156	154	699	155	67	163	3395	164	182	159	2411
185	381	194	15998	184	861	185	80	193	4042	194	223	189	2941
215	466	224	18835	214	1018	215	93	223	4706	224	266	219	3469
245	549	254	21698	244	1174	245	105	253	5382	254	309	249	4000
275	630	284	24570	274	1327	275	117	283	6054	284	355	279	4532
305	710	314	27419	304	1470	305	129	313	6727	314	400	309	5058
335	788	344	30244	334	1601	335	141	343	7416	344	445	339	5578
365	862	374	33045	364	1739	365	154	373	8122	374	491	369	6094
395	934	404	35820	394	1892	395	168	403	8857	404	541	399	6610
425	1004	434	38578	424	2054	425	180	433	9641	434	591	429	7126
455	1070	464	41322	454	2230	455	191	463	10469	464	639	459	7642
485	1134			484	2405	485	204	493	11323	494	686		
512	1176			514	2557	515	214	523	12195	524	736		
539	1201			544	2702	545	225	553	13080	554	790		
566	1220			574	2836	575	237	583	13976	584	850		
593	1237			604	2951	605	249	613	14881	614	907		
620	1253			634	3061	635	259	643	15791	644	960		
647	1268			664	3167	665	270	673	16713	674	1014		
674	1282			694	3265	695	281	703	17647	704	1071		
701	1296			724	3359	725	292	733	18572	734	1128		
728	1311			754	3451	755	303	763	19485	764	1185		
755	1324			784	3539	785	315	793	20390	794	1244		
782	1337			814	3623	815	326	823	21293	824	1305		
809	1350			844	3709	845	337	853	22205	854	1366		
836	1363			874	3793	875	348	883	23134	884	1423		
863	1376			904	3872	905	359	913	24077	914	1477		
890	1388			934	3950	935	371	943	25015	944	1532		
917	1400			964	4030	965	383	973	25944	974	1587		
944	1413			994	4112	995	395	1003	26884	1004	1644		
971	1425			1024	4200	1025	406	1033	27845	1034	1700		
998	1437			1054	4288	1055	418	1063	28811	1064	1753		
1025	1449			1084	4374	1085	429	1093	29783	1094	1806		
1052	1460			1114	4458	1115	440	1123	30770	1124	1858		
1079	1472			1144	4544	1145	451	1153	31764	1154	1908		
1106	1484			1174	4632	1175	462	1183	32769	1184	1957		
1133	1496			1204	4708	1205	474	1213	33782	1214	2009		
1160	1508			1234	4770	1235	486	1243	34773	1244	2061		
1187	1519			1264	4825	1265	498	1273	35730	1274	2113		
1214	1531			1294	4875	1295	511	1303	36653	1304	2163		
1241	1543			1324	4920	1325	522	1333	37550	1334	2214		
1268	1554			1354	4965	1355	533	1363	38431	1364	2265		
1295	1566			1384	5008	1385	545	1393	39298	1394	2312		
1322	1577			1414	5052	1415	557	1423	40166	1424	2357		

Note 1: The time given for each sampling area is the average of the elapsed times for the three swatches tested per sampling area.

Note 2: The avg. time is the sum of the times given for each sampling area divided by the number of sampling areas.

Note 3: Weighted average Mf = 0.5(Suit Matl Mf) + 0.15(Suit Seam Mf) + 0.15(Visor Matl Mf) + 0.1(Boot Seam Mf) + 0.05(Suit/Visor Interface Mf) + 0.05(Zipper/Matl Interface Mf).

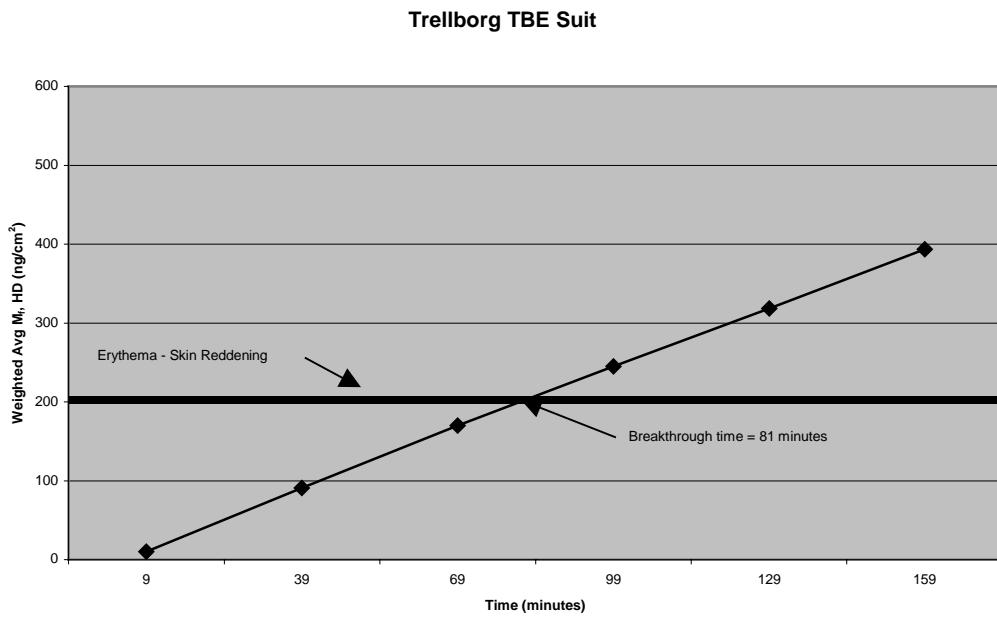


Figure I- 3: Trelleborg Trellchem TBE - Weighted Average HD Permeation

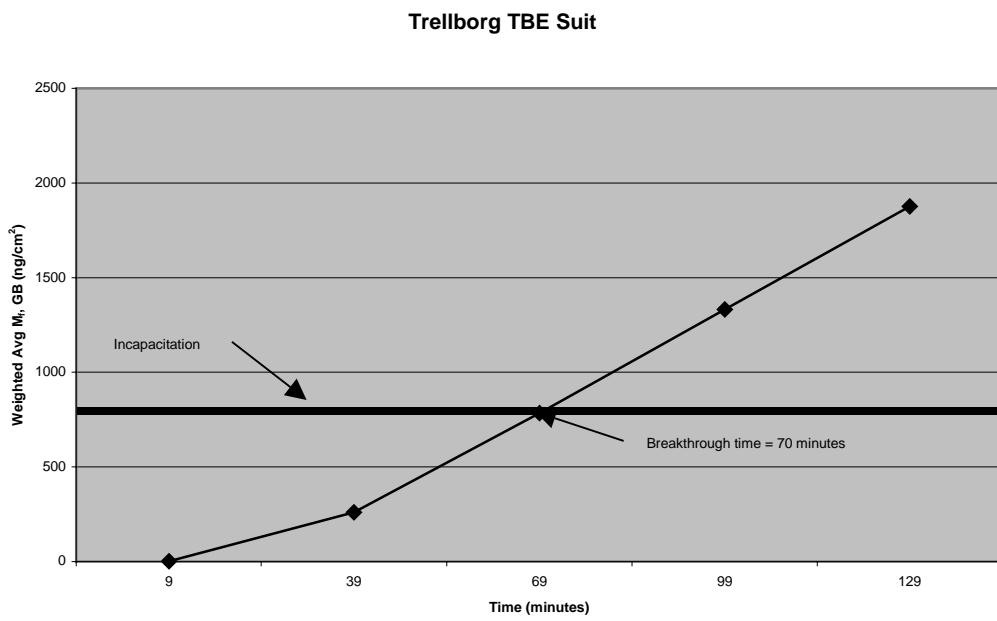


Figure I- 4: Trelleborg Trellchem TBE - Weighted Average GB Permeation

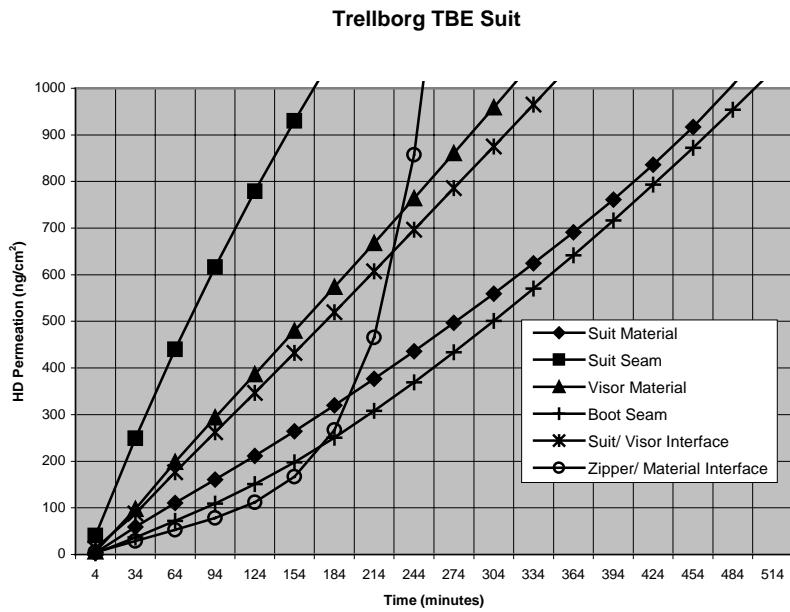


Figure I- 5: Trelleborg Trellchem TBE: HD Permeation by Sampling Area

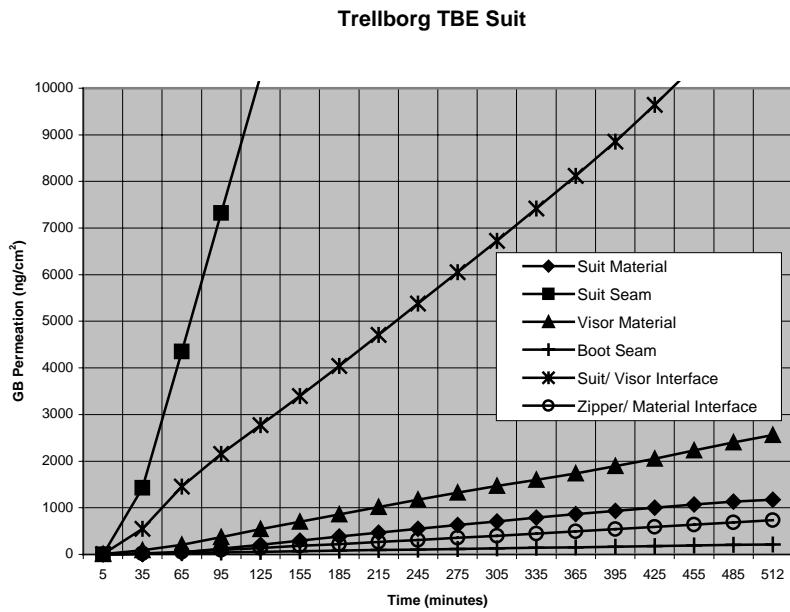


Figure I- 6: Trelleborg Trellchem TBE: GB Permeation by Sampling Area

Table I- 3. Trelleborg Trellchem TBE- System Test (Aerosol Simulant) Results

PF	Visor Region and Upper Arm, Combined					
	Pre-Operational Exercises			Operational Exercises		
	No. of Occasions	Cumulative Rate, Percent	Cumulative Pass Rate, Percent	No. of Occasions	Cumulative Rate, Percent	Cumulative Pass Rate, Percent
0	0	0	100	0	0	100
10	0	0	100	0	0	100
50	0	0	100	0	0	100
100	0	0	100	1	2.1	97.9
150	0	0	100	0	2.1	97.9
500	0	0	100	0	2.1	97.9
1000	0	0	100	0	2.1	97.9
1667	1	2.1	97.9	0	2.1	97.9
2000	1	4.2	95.8	0	2.1	97.9
5000	38	83.3	16.7	1	4.2	95.8
6667	5	93.8	6.2	2	8.3	91.7
10000	3	100	0	4	16.7	83.3
20000	0	100	0	18	54.2	45.8
50000	0	100	0	16	87.5	12.5
100000	0	100	0	6	100	0
No. of Trials	48			48		

Table I- 4. Trelleborg Trellchem TBE - Overall Test Results

Breakthrough Time (minutes)		Aerosol PF Pass Rate at PF Equal to:			Exercise Phase
Incapacitation	Erythema	100	1000	2000	
GB	HD				
70	81	100	100	95.8	Pre-Operational
		100	97.9	97.9	Operational

Blank

Appendix J -
Overall Test Results

Summary of HD Permeation Results

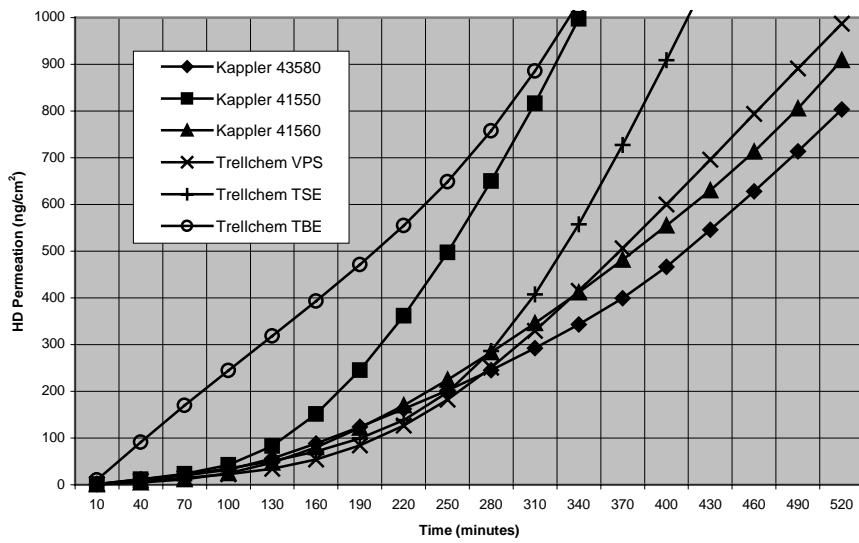


Figure J- 1: Weighted Average HD Permeation

Summary of GB Permeation Results

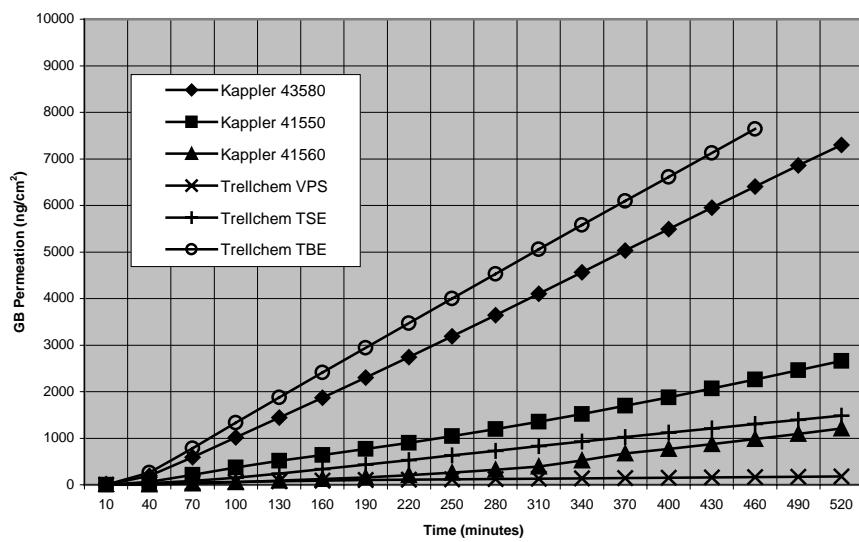


Figure J- 2: Weighted Average GB Permeation

Table J- 1. Summary of Overall Results for all Level A Suits

Test Item	Breakthrough Time (minutes)		Aerosol PF Pass Rate at PF Equal to:			Exercise Phase
	Incapacitation	Erythema	100	1000	2000	
	GB	HD				
Kappler Responder Plus 43580	84	249	100	65.2	47.8	Pre-Operational
			100	89.1	73.9	Operational
Kappler Lifeguard Responder 41550	196	175	100	66.7	29.2	Pre-Operational
			100	72.9	45.8	Operational
Kappler Responder/NFPA Ensemble 41560	408	237	100	72.2	48.2	Pre-Operational
			100	68	52	Operational
Trelleborg Trellchem VPS Suit	>1440	257	100	100	91.7	Pre-Operational
			100	95.4	95.4	Operational
Trelleborg Trellchem TSE Suit	300	250	100	100	95.8	Pre-Operational
			100	97.9	97.9	Operational
Trelleborg Trellchem TBE Suit	70	81	100	100	95.8	Pre-Operational
			97.9	97.9	97.9	Operational